SHRAPNEL AND OTHER WAR MATERIAL

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Shrapnel and Other War Material

A NATION depends very largely upon its machine shops for industrial prosperity in time of peace—for machinery building is the basic industry upon which all manufacturing depends. In time of war these same machine shops must produce the materials for defense, a lesson which the Canadian shops have learned to the fullest extent during the past few months.

Thus as a patriotic measure, it behooves machine-shop owners and managers to become familiar with the general methods of making munitions of war, and to analyze their own capabilities along these lines if occasion to put them to use should arise. This is not predicting in the slightest degree that the occasion will arise, but advocates a business-like attitude on the part of the machinery-building industries of our country. The adoption of this attitude will eliminate serious delay if the remote possibility should ever become a fact.

But entirely aside from this feature of the subject, descriptions of processes that have been developed to produce shells, guns and other war material are of value in themselves. The methods now being used in Canada and the United States are strictly uptodate. Standard automatic machines, and in some cases special automatic machines, are being used. Beyond all this, regular machine-shop equipment has been adapted by developing special holders, fixtures and cutting tools. The inspection system is most rigorous. Limit gages are plentifully used. Not only are many of the dimensions expressed in thousandths or parts of a thousandth of an inch, but the weight of large pieces must be held within a few drams of the fixed standard.

Thus from the double viewpoint of meeting a patriotic duty and learning of advanced shop practice the manufacture of war munitions, as set forth in the following pages, deserves careful consideration of everyone engaged in machinery building.

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What a Shrapnel Is and Does

By J. P. Brophy*

SYNOPSIS—Shrapnel have proved to be invaluable tools in modern warfare, which consists so largely of trench storming and defense. Comparatively few know how the shrapnel is timed to explode at the right moment, or how the destructive rain of shot is caused by the internal explosion. The following article explains these points and conveys a clear idea of what a modern shrapnel really is.

Shrapnel shells of all countries have a similar outside appearance, although they vary slightly in length and form. Inside they are all somewhat similar, but the various parts may be of different shapes. The final result, however, is practically the same.

The illustration shows a shrapnel shell casing such as is being used so extensively in the European war. These shells are manufactured in sizes from 2 to 15 in. in diameter. The following description will perhaps be interesting:

The brass shell *A* that envelops the outside of the shrapnel casing is filled with powder, which is carefully measured to have the exact amount in each shell. This powder is ignited similarly to a cartridge in a gun and is intended to discharge the shell from the gun.

At *B* is a powder pocket which contains the necessary amount of powder to explode the casing and scatter the charge.

A copper band, which is shrunk and also hydraulically pressed over the body of the shell, is shown at *C*. The outside diameter is turned somewhat larger than the gun bore, which is rifled or grooved in a spiral through its entire length.

When the shell is placed in the gun, the breech end admits it freely, but the gun bore being somewhat smaller and the copper being soft material, it is compressed and a portion of the copper ring sinks into these spiral grooves. Thus, when a shell is fired it has a rotary motion corresponding to the spiral of the gun, which means that the shrapnel is revolving at the same time it is traveling longitudinally. The rotary motion is so rapid that it keeps the shrapnel in practically a straight line laterally in its flight. If the gun did not have spiral grooves, when the shrapnel started to travel it would swerve against the resistance of the air, which would make it impossible to determine in what position it would explode. In other words, a smooth-bored gun and a smooth-surface shrapnel could not be depended upon for accuracy, and no scientific calculations could be made whereby shrapnel fired one after another would land in about the same place.

From this explanation it will be understood that the piece *C* is an important part of the shrapnel.

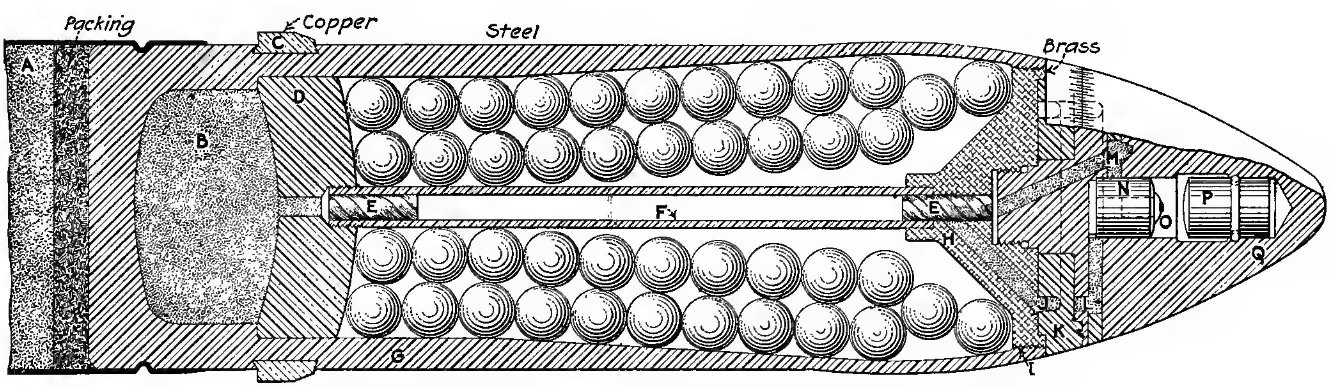
Details of Design

A steel washer, which is pressed in position, is shown at *D* separating the powder pocket from the chamber of the shrapnel proper. This is commonly called "the diaphragm."

A copper tube connecting the powder pocket *B* with the fuse body *H* is shown at *F*. This contains an igniting charge of gun cotton *E* at either end.

The shell casing is shown at *G*, the fuse body at H and a powder passage *J* is shown at an angle connecting with the gun cotton.

The threaded connection between fuse and shrapnel bodies at *I* is of fine pitch, so that when the powder is ignited at *B* the threads strip, allowing the balls to be discharged. After the powder is ignited, if the pressure is not great enough to destroy the thread, the shell casing will burst at the end, which is its weakest point, and open up in umbrella shape, the balls and body of the shell being driven with great force in all directions similar to the explosion of a skyrocket. This is very destructive within a radius of 60 ft. from where the explosion occurs.



Cross-Section of a Common Shrapnel

The Timing Device

We are now coming to the most interesting part of the shrapnel, the timing device.

The time ring, graduated on its periphery, is shown at *K*. This controls the time of igniting the fuse *J*. When the time ring is set to zero the shell explodes just after it leaves the muzzle. The graduations indicate the explosion time at practically any number of feet desired up to the full range of the gun. On the inside of the graduated ring *K* a small opening is milled for about three-fourths of a circle, so that the fuse cannot burn all

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way around. In this small opening the time fuse is placed, and at the bottom of the ring are small holes.

A loose piece N moves freely and carries at O an ignitible and highly explosive substance, which is so sensitive that if one drop were struck with a lead pencil held in the hand, it would shatter the end of the pencil before it could be withdrawn.

When the gun is in position, the range finder immediately estimates the distance to the enemy, and this information is given the gunners. The ring K is moved to the position which indicates the number of yards the shrapnel will travel after leaving the gun before it explodes. This is all taken care of in a few moments. The fuse on the inside of ring K, when ignited, burns in the direction that leads to the powder passage J, and the time taken to reach this determines the distance that the shrapnel will travel before exploding.

When the powder at J commences to burn, it ignites the gun cotton at E, and the flame passes through the tube F to the gun cotton at the opposite end, igniting the powder at B. The time taken by the flame to travel from J to B is difficult to estimate because of its rapidity, but may be compared to the speed of electric current.

How the Fuse Is Ignited

A piece called a "free-moving slug" is shown at P. The moment the gun is fired, the shrapnel travels with such great rapidity that it causes this moving slug to rebound and come in contact with O. The ignitible substance at O creates a flash, which burns back and around the chamber to the powder L, which leads to the fuse embedded in the face of the graduated ring K. The time, reckoned in fractions of seconds, that it takes to burn the fuse in the ring K before it reaches the powder J is calculated according to the distance the shell travels in flight before the charge is to be ignited at B.

If the shrapnel fails to explode at the correct distance because of the slug P not responding, then at the moment it comes in contact with anything in its path the sudden impact will carry forward the loose piece N, which is free to oscillate. This will mean a contact of the ignitible substance at O with the piece P. Ignition immediately takes place, and as piece N is in the forward position, the flame will travel in the direction of M. This action reverses the direction of the flash, as already explained. This means direct ignition through the powder passage M to the powder pocket B at lightning speed. The consequence is an instantaneous explosion of the shell at the moment it comes in contact with any object in its path, and extreme destruction at this point.

Refinements of Destruction

The outside shape of the fuse body O is such as to offer the least resistance; in other words, it breaks up the air as it bores its way through. If this nose were longer or shorter, or a different shape, it would offer great resistance, which would lessen both its speed and its range.

The muzzle velocity of the 3-in. shrapnel shell, which is being used so extensively abroad, varies from 1500 to 1900 ft. per sec. during the first second of flight, and because of the air resistance, diminishes in speed gradually through the remaining distance that it travels. The maximum effective range is about 6000 yd., and as the time fuse can be set to explode at 100 yd. or less, and at any point up to 6000 yd., the time it would take to travel 100 yd. would be about one-sixth second.

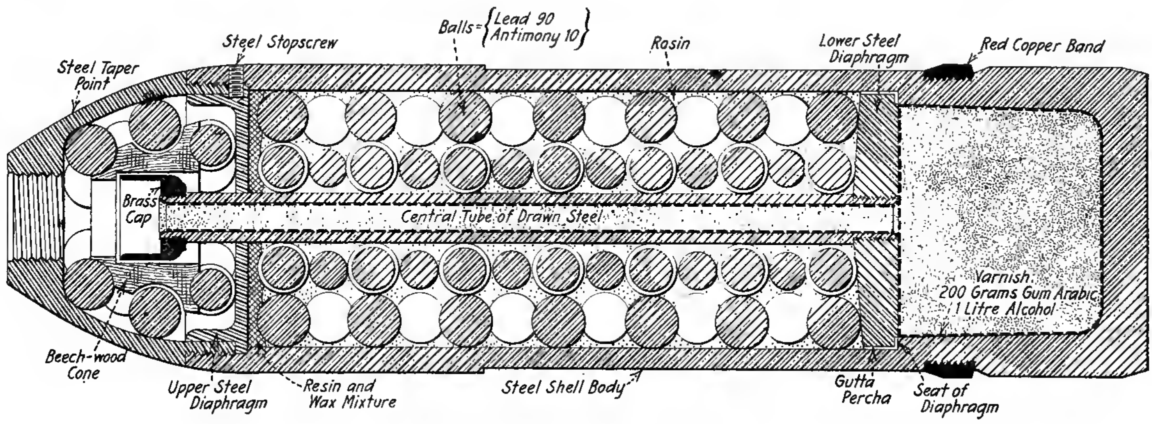
The balls are placed in the position shown and a special wax is melted and poured around them so that they are practically a solid mass. The destruction which takes place when these balls, traveling at great velocity, spread in the midst of hundreds of human beings can easily be imagined.

The French 75-mm. Shrapnel

The shrapnel shell used in the celebrated 75-mm. French field gun differs in many details from the American and British shells. No powder cup is used, and a nose containing balls is fitted in place of the timer. The fuse is screwed into this nose, the thread to receive it being shown in the illustration. A feature of this loaded nose is the wooden holder that carries the lead balls. These are composed of 90 parts lead and 10 parts antimony.

The space for the powder charge in the base of the shell is varnished on all surfaces with a varnish composed of 200 grams of gum arabic cut in one liter of alcohol. This coating is also applied to the lower surfaces of the lower steel diaphragm. This diaphragm is seated in a packing of rubber to make a sealed joint.

Another point of difference between the British and French construction is the method of keying the copper band. The British design calls for cutting a series of waves or drunken threads, around which the dead soft copper band is swaged. The French construction merely cuts a series of V-grooves into which the band is compressed.



French 75-mm. Shrapnel

Forging the Blanks for 18-Lb. British Shrapnel—I

By E. A. Suverkrop

SYNOPSIS—In the shops of the Montreal Locomotive Co., Montreal, Canada, 3000 *shell blanks,* 10 *in. long,* 3½ *in. diameter and* ¼ *in. thick in the wall, are being made every* 24 *hr. The blanks are* 0.50 *carbon steel,* 4⅞ *in. long and* 3½ *in. diameter. These blocks of steel are heated and, in two operations, squirted and drawn, with an allowable error of* 0.01 *in. on the surfaces not subsequently machined, to the dimensions given above.*

The hot squirting of 0.50 carbon steel cups is said to have originated in England, but as far as Canada is concerned the operation was first performed in the Government Arsenal at Quebec. Since the beginning of the war, however, the government shops have been open to inspection and every assistance has been given the representatives of private plants which have undertaken the manufacture of ammunition. In turn, each manufacturer has added his little to the fund of knowledge, and this has cheerfully been handed along the line.

Before going further, I wish to thank every man at the shops of the Montreal Locomotive Co. for the courtesy and patience with which they answered my questions and explained everything to me.

In Fig. 1 are shown the stages of evolution from the bar-stock blank to the forging trimmed to length.

Just as the existing lathes, planers, etc., in the machine shop were put to work pending the arrival of more suitable tools, so in the forge shop the large flanging press shown in Fig. 2 and the heavy bulldozer shown in Fig. 8 were set to forging the shell blanks until special presses could be built and delivered. These special presses are now at work, but as it is a question of "deliver the goods," the flanging press and the bulldozer are still on the job day and night, for in the ammunition shops 24 hr. is a day.

The steel for these forgings comes in ordinary straightened commercial bars 10 to 12 ft. long. The specifications call for 0.45 to 0.55 carbon, 0.70 manganese and less than 0.04 sulphur and phosphorus.

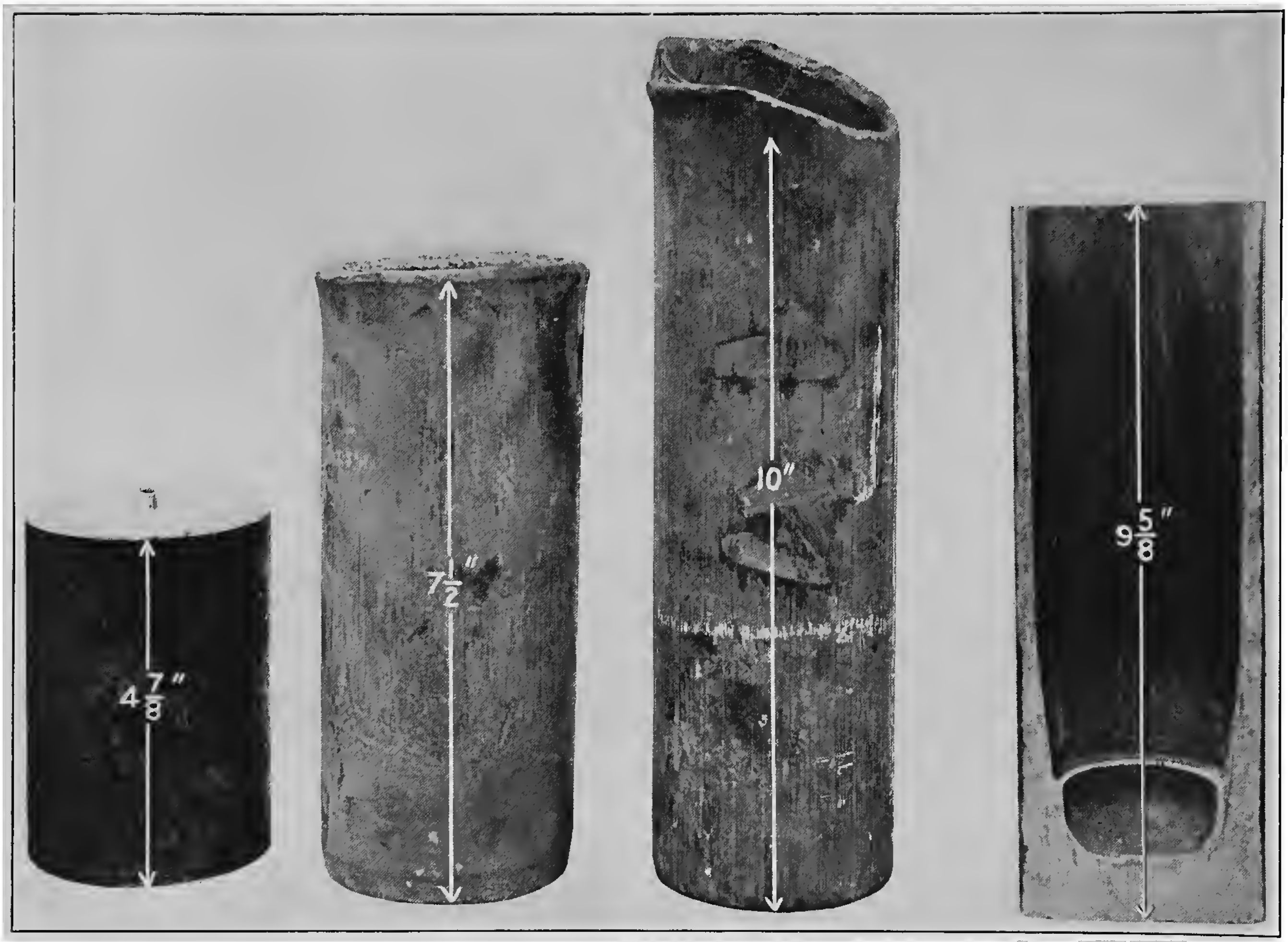


Fig. 1. The Stages of Evolution from the Bar-Stock Blank to the Forging Trimmed to Length

The steel mill stamps a number on each bar of a shipment made from a certain "melt." Test pieces from each melt are first analyzed and broken by the Canadian Inspection Co. Having passed this inspection, three bars are selected by the Montreal Locomotive Co.'s chemist from each "melt," and two pieces are cut from each of these bars. Of the two pieces from each bar, one piece is analyzed and the other is made into a shell, going through all the operations up to and including heat treatment.

The cutting of the bars to forging length is the first operation. Three thousand forgings are now required each day, and every machine at all adaptable to this work

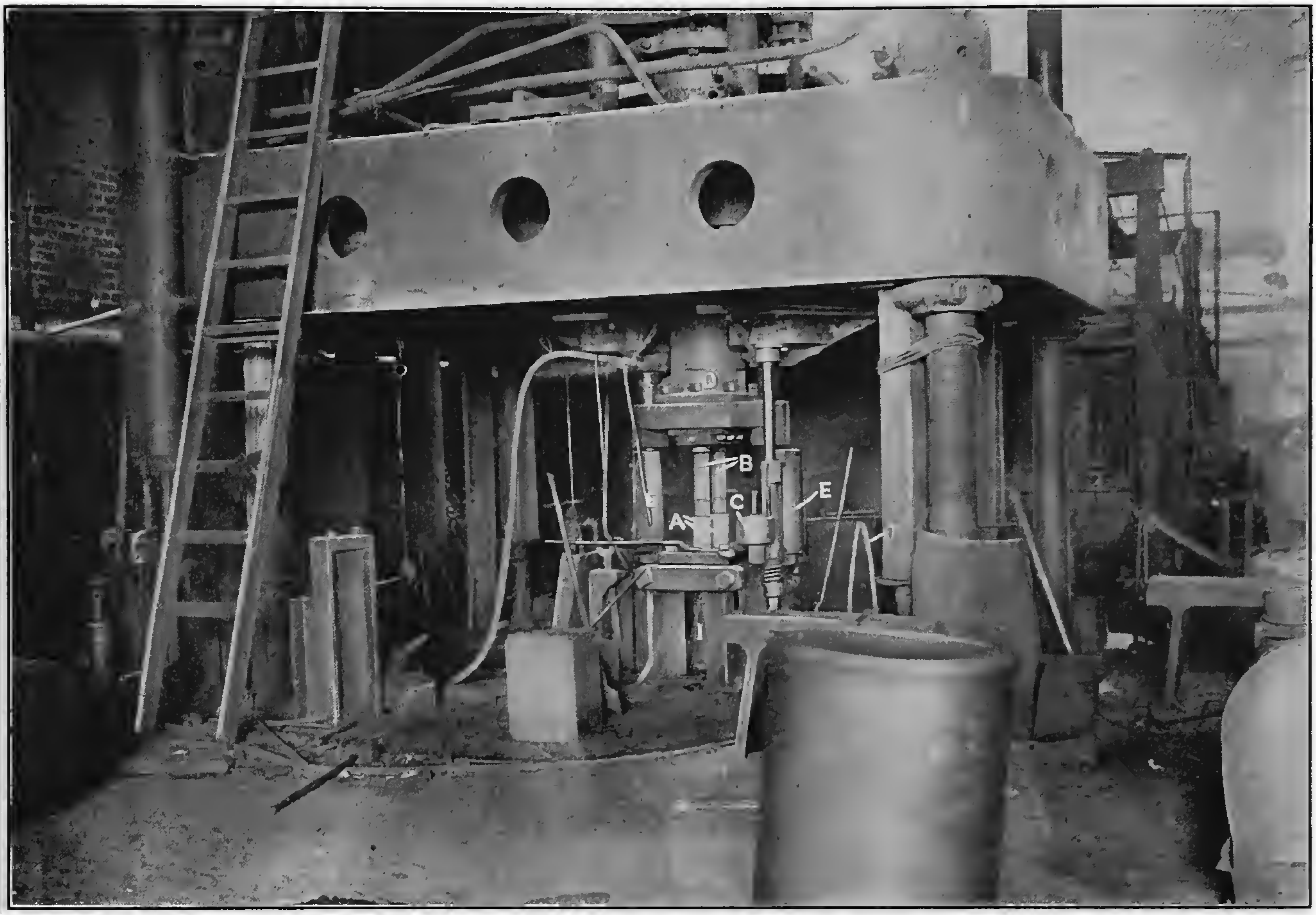


Fig. 2. Large Flanging Press

has been requisitioned for cutting bars to the specified length of 4⅞ in. Four methods of cutting are at present

The scleroscope test is also made, which helps to determine the heat treatment. Test pieces are then cut from the shells, and the tensile strength ascertained. Having passed the tests, the rest of the bars in the melt are cut to

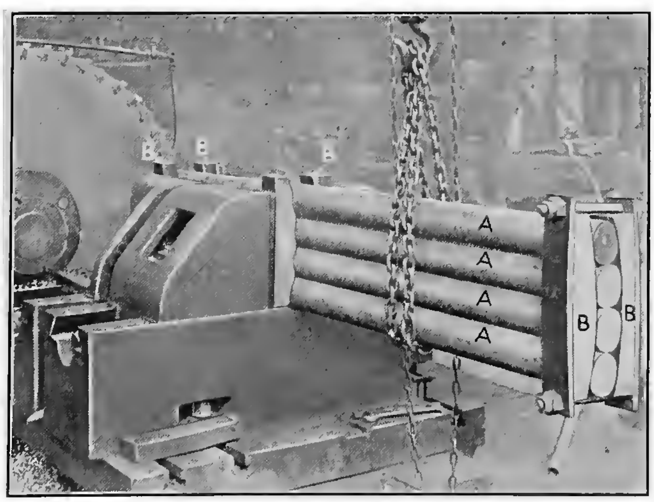


Fig. 3. Cutting Blanks on a Newton Cold-Saw

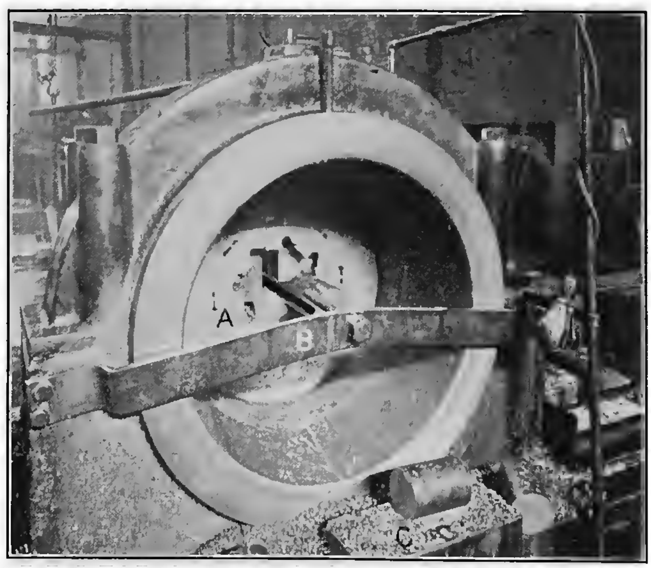


Fig. 4. Gorton Cold-Saw

the standard length of 4⅞ in. for shell-forging blanks, the blanks from each melt being kept together throughout manufacture.

employed, as shown in Figs. 3 to 6, and these will be augmented soon by a heavy slab miller with a gang of high-speed saws. Two jigs will be used, each holding the full capacity of the miller table. While a cut is running, the operator will be busy unclamping the severed blanks and reloading the other jig. The jigs and work will be handled to and from the miller by a hoist.

Cold-Saw Cutting

In Fig. 3 is shown a large Newton cold-saw cutting four blanks at a pass. . The bars *A* are held between the soft-wood clamps *B*, which are shaped to bring the bars to the same circle as the saw, thus reducing the travel and time of cutting to a minimum. Hardwood was tried at first, but did not grip the bars securely. On this machine 250 blanks can be cut in 10 hr. The clamps to the extreme right are not loosenèd until the bars are too short to handle in the saw, thus avoiding a lot of unnecessary adjusting of the individual bars.

In Fig. 4 is shown a Gorton saw on the same work. This saw has a capacity of 190 blanks in 10 hr. The stop

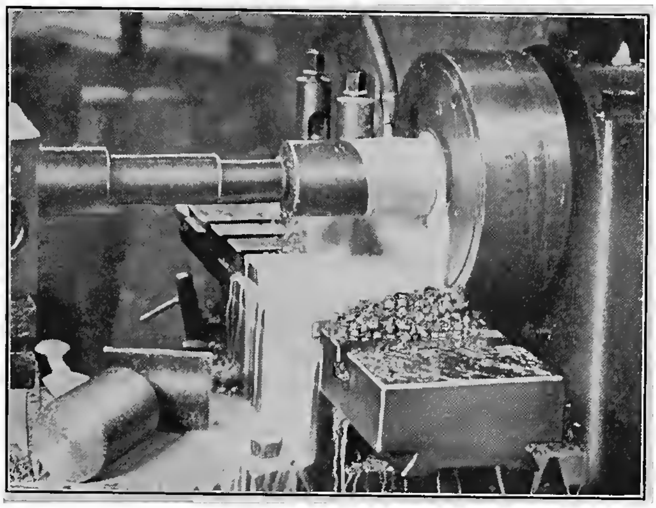


Fig. 5. Cutting Blanks on Turret

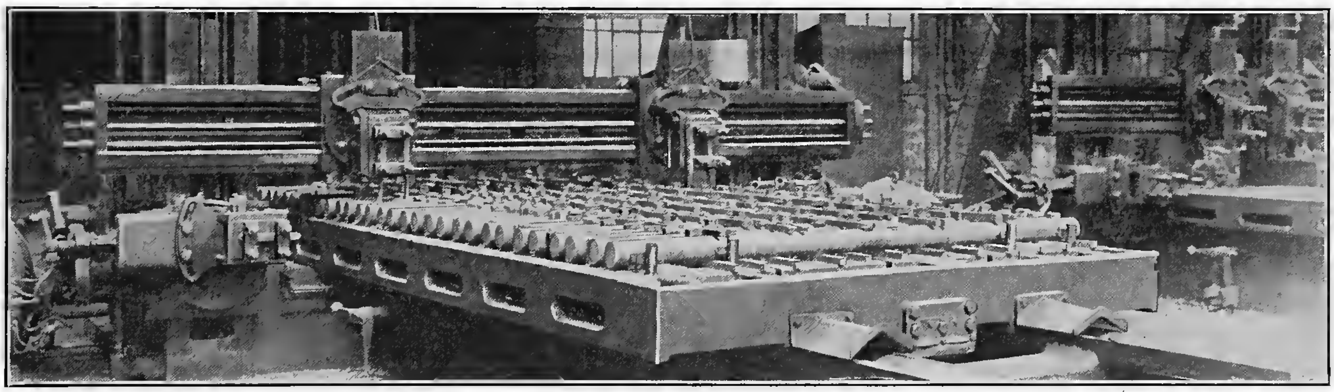


Fig. 6. Cutting Blanks on the Planer

A was at first secured to a bracket attached to *C*. When thus attached, its position with regard to the work was stationary and trouble was encountered with the nearly severed blank jamming between the stop and the saw and breaking out the teeth. With the bracket *B* secured as shown to the saw housing, the stop *A* is in contact with the end of the bar only when the saw is out of contact with the work. During the cut it is entirely out of contact, and at completion of the cut the blank is free to drop clear of saw and stop.

In Fig. 5 is shown a turret lathe used for cutting blanks. On the machine shown 265 blanks can be cut in 10 hr.

In Fig. 6 is shown the cutting of blanks on a large planer. The bars are held down by ordinary strap clamps and spacers are placed between them. Special holding devices for tools and work are in course of construction, whereby the output by this method will be from 400 to 600 blanks per day. Two tools are used in each head. The outer tools on each side are about ¾ in. in advance of the inner tools so as to leave enough metal to resist the bending stresses. With all these methods ordinary cutting compound is used as a lubricant.

Removing the Burr

A burr is left on all blanks except those which are cut while the bar rotates. This must be removed. The removal is a simple job with a pneumatic chisel, but the method of holding the work is worth showing. The machine steel block *A*, Fig. 7, secured to the bench is about 3½ in. high, 6 in. wide and 20 in. long, and weighs about 100 lb. The blank *B* is gripped by a ⅞-in. setscrew operated by a

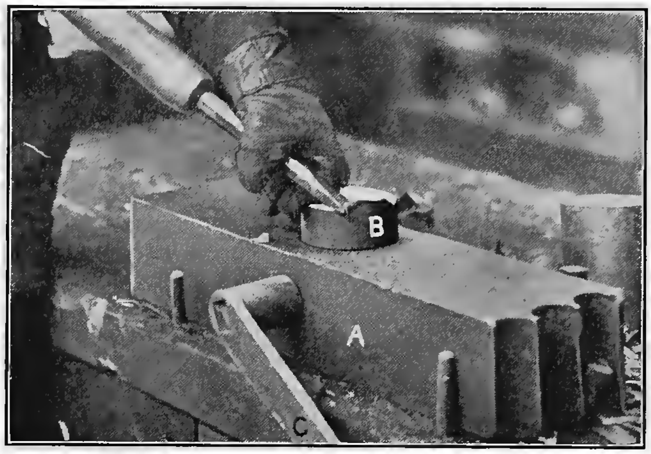


Fig. 7. Removing Burrs

long crank handle *C*. The inertia of this heavy block steadies the work and makes cutting an easy matter. The crank handle is quickly operated. One operator can easily remove the burrs from all the blanks.

Forging

Forging was first undertaken in the heavy flanging press, Fig. 2, the bulldozer, Fig. 8, and drop presses, not shown. That the reader may appreciate the excellence of this work, I would especially call his attention to the dimensions and limits on Fig. 9 and then remind him that the men before its inception were forging locomotive frames, and that many of them probably never heard of a hundredth of an inch. Further, the metal is worked hot and shrinkage must be allowed for, and finally both the shop and the government inspectors reject any work not up to specifications.

First Forging Operation

The cut-off blanks are charged into ordinary reverberatory furnaces, of which there are two for each press. The furnaces are fired with oil at 25-lb. pressure and air at 7 oz. Each press is equipped with two sets of punches and dies, as shown in Fig. 10. The punches are made of 0.70 carbon steel, finished all over and hardened but not drawn. The dies are made of 0.70 carbon steel or chilled iron. It has been found that new punches and dies have a tendency to stick to the work unless they are first heated.

The work of adapting the large flanging press and bulldozer to shell forging was taken care of by Robert Allison, works engineer, and while these two machines are now employed for the second operation, a description of the fixtures applied to them will not be out of place. In Fig. 11 is shown

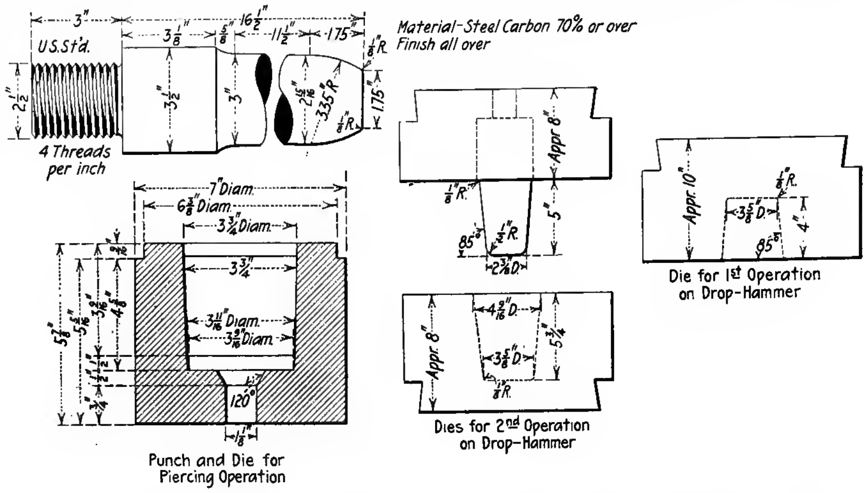


Fig. 10. Punches and Dies for First Forging Operation on Presses and Drop Hammers

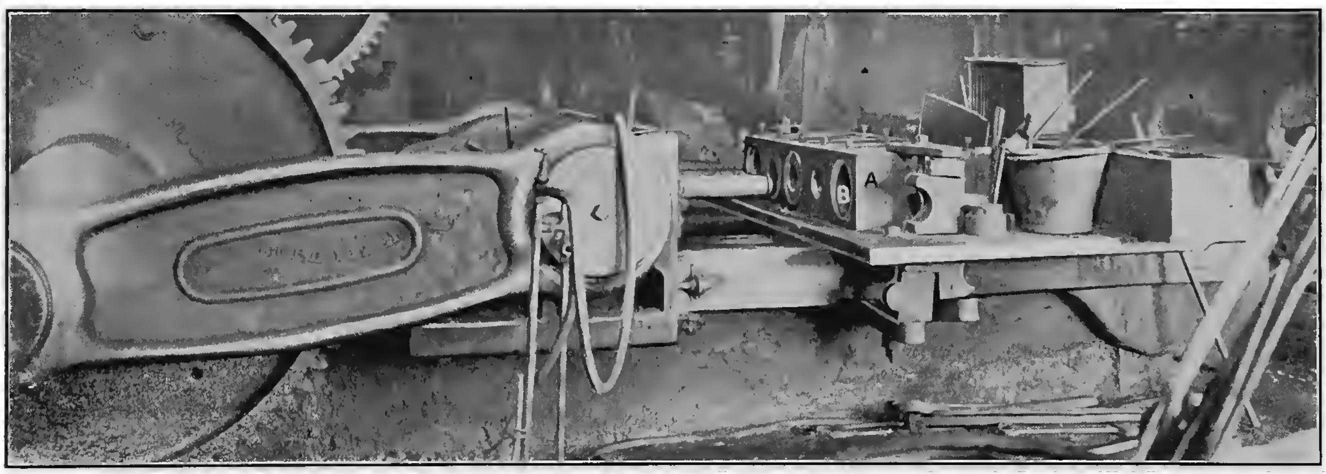


Fig. 8. Forging Shell Blanks on a Bulldozer

the fixture for the flanging press. With the exception of the punches and dies, which are for the second, or drawing, operation on the shell blanks, the fixture is the same as used for the first operation. The same reference letters will be used in Figs. 2 and 11.

The flanging press is 155 tons capacity with a stroke of 30 in. It was found that to assure proper stripping a pull-back of 25 tons per forging is necessary. For that reason the pull-back on the press was increased to 55 tons.

Equipment for Flanging Press

The flange *G* is bolted to the upper platen. The distance-piece *D* connects with the original ram to bring the tools to handy working height. The two punches *B* are secured in the head as shown. A swinging stop operated by the handle *C* is disposed on each side of the press. In the plan view to the right the stop *E* is shown swung out of the way, while to the left it is in operating position. The swinging stop is used only when the second operation is in progress. At *F* are the guides for the punch head; at *H* are the seats for the dies for both first and second operations; at *I* is a cored opening for the removal of the work on completion of the second operation.

When the blanks have attained the proper temperature, a press feeder at each furnace removes one with a pair of tongs and, swinging it over his head, brings it down end-on against an iron block to jar off as much of the scale as possible. Two men with the scrapers *A*, Fig. 12, and brooms then rapidly remove the rest of the scale and the feeders place the blanks in the dies. They then drop their tongs and take the guide *B*, Fig. 12, and lay it on top of the hot blank. The 3⅝-in. recess is downward, surrounding the hot blank and centering it. The punch then descends, enters the $3\frac{1}{32}$-in. opening on top, centers the guide and work with relation to itself and, passing on down, causes the hot metal to squirt upward around the punch. The press is then reversed and the punch ascends, bringing with it the forging, which is now about 7½ in. long. Occasionally a forging will seize; then the punch is unscrewed and a new one inserted, which takes but a few minutes. When things are running right, the press will turn out 1000 first-operation cups in 10 hr. At *C* in Fig. 12 is shown the blowpipe for removing scale from the dies in the first operation and at *D* the one for removing scale from the dies in the second operation. At *E* is shown the spray for cooling the punches in the second operation when they get too hot. The length of service of a punch or die depends upon may variables; it is, however, not uncommon for a die to last 24 hr.

As the requirements for the insides of the shells are more exacting, there being no machining inside except at

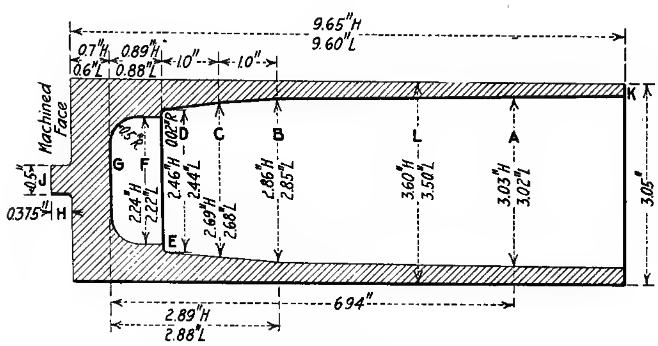


FIG. 9. SHELL SHRAPNEL

(Dimensions in Inches)

(1) Dimensions "A," "B" and "C" are the finished internal sizes of shell. (2) At "D" this dimension allows material for machining equal to 0.05 in. per side. (3) The material on inside wall allowed for machining from "C" to "D" tapers from 0.0 to 0.05 in. per side. (4) At the shoulder "E" on which disk rests material 0.1 in. is allowed for machining. (5) At "F" material is allowed for machining equal to 0.05 in. per side. (6) At "G" material is allowed for machining equal to 0.05 in. Care must be taken to remove all scale from this part. (7) Face "H" to be machined by forging manufacturers. (8) Projection "J" to be left as shown on base unless otherwise specified when forgings are ordered. (9) Face "K" to be machined by forging manufacturers to dimensions given. (10) Dimension "L" allows for machining, but this should not exceed 3.55 or 3.50 in. (11) Inside finish of forgings from mouth of shell at face "K" to dimension "C" to be smooth and free from scale, projections, irregularities and other blemishes. The body must also be straight.

the bottom, the punches under normal conditions require to be replaced more often than the dies, averaging 4 to 5 per day.

The gage *H*, Fig. 12, is used in inspecting the finished forging. The short leg goes on the inside of the shell, the difference between the length of the legs indicating the proper base thickness.

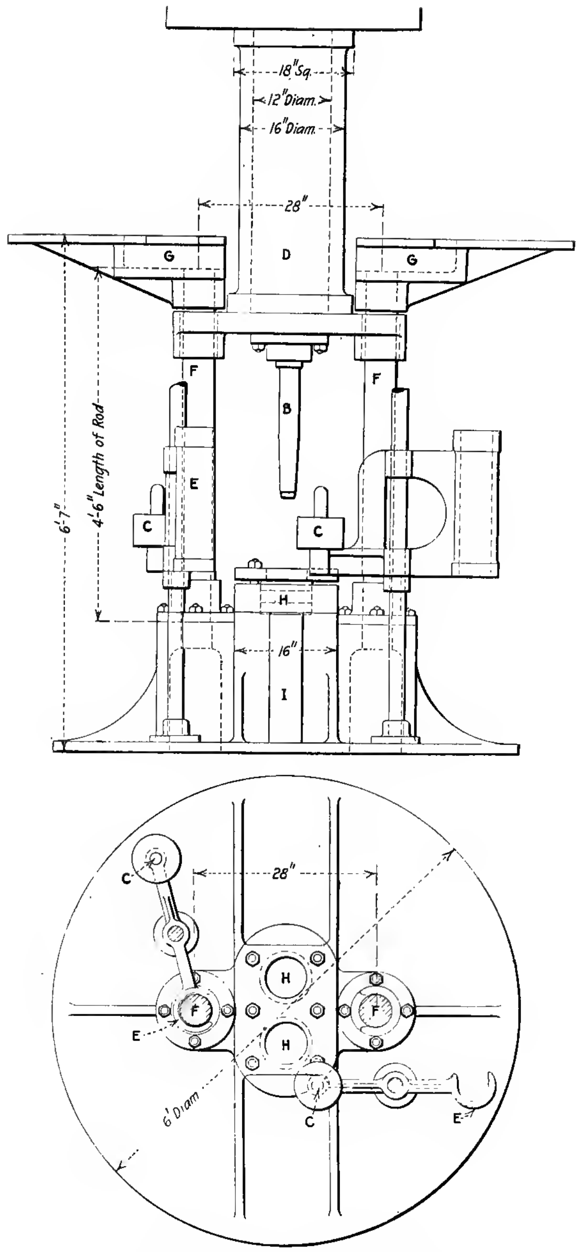


FIG. 11. EQUIPMENT SHOWN FOR SECOND OR DRAWING OPERATION

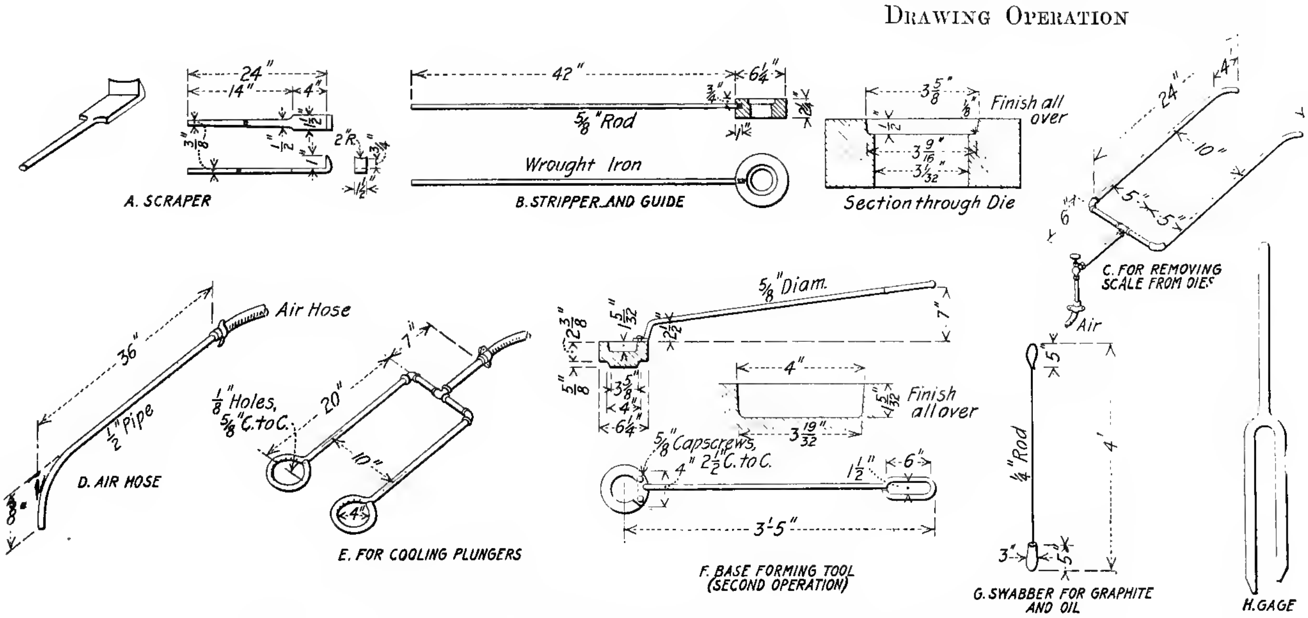


FIG. 12. ACCESSORIES IN CONNECTION WITH HYDRAULIC FORGING PRESS

Forging the Blanks for 18-Lb. British Shrapnel--II

By E. A. Suverkrop

SYNOPSIS—In this second installment of the first authentic article from the field covering shell forging, a number of practical hints are included in connection with both the forging and drawing operations. Details of the automatic base-forming stops and strippers are also given and the heat-treating methods are described.

The special R. D. Wood & Co. press, shown at the left in Fig. 13, is used for the first operation, and the special fixtures designed by Mr. Allison to secure accuracy and high production are illustrated in detail in Fig. 14. Owing to poor lighting conditions, it was impossible, even with a flashlight, to get a good photograph of the special presses.

Special Fixtures for First Forging Operation

Referring to Fig. 14, the punches are shown at *A*. The plates *B* (in connection with the guide and stripping tool *B*, Fig. 11) strip the finished work from the punch. The dies, Fig. 9, are seated at *C*. The knock-out *D* is operated by the frame *E* hung from the ram by chains in the eyebolts; these chains are visible in Fig. 13. The knock-out *D* is simply a rivet which is actuated by the frame *E*. It will be noted that the chains *G* are at an angle. When the frame is in this position the bottom of the knock-out *D* enters a hole in the frame member under it and the top of *D* comes flush with the bottom of the die. When the punch *A* descends, the frame also descends. As soon as it clears the end of the knock-out *D*, the frame *E* swings by gravity to such position that when the punch and frame again ascend, the bottom of the knock-out *D* is struck and the work is ejected from the die *C*. After removal of the work, the operator pushes the frame with his foot in the direction of the arrow until the stop *H* strikes the frame of the press, when the knock-out *D* again drops into the pocket in the frame *E* and the die *C* is ready to receive another blank.

In construction, the two stops *I* are simple and efficient. Under the repeated pounding, the punches and stops are bound to upset slightly so that adjustments of stroke must be made from time to time. Adjustment is secured in the following simple manner: On top of each of the posts *I* are two inverted cups *J* with sheet-steel shims, one or more of which can be removed or inserted to readjust the length of stroke.

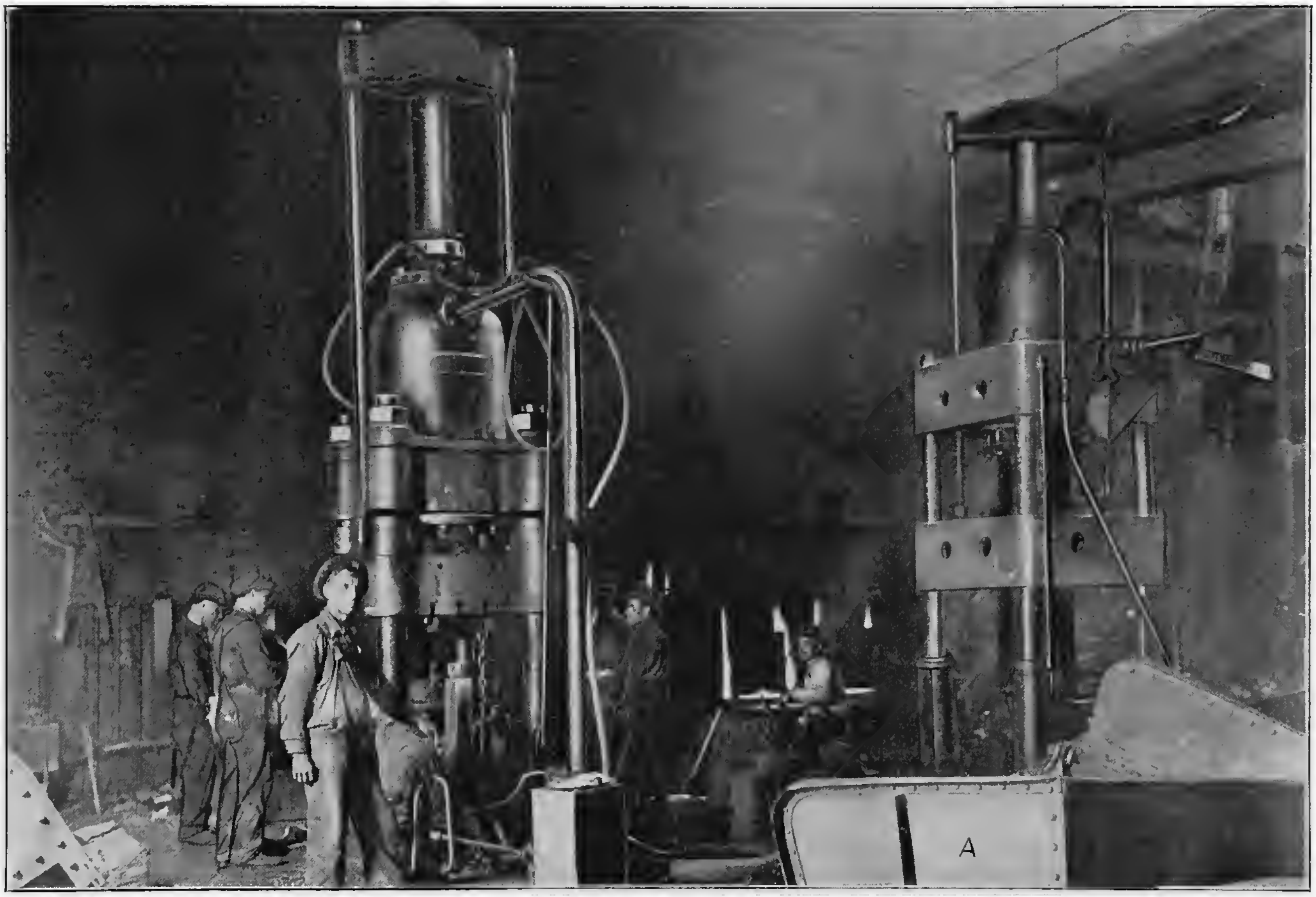


Fig. 13. R. D. Wood & Co. Press to Left and Niles Press to Right

Second Forging Operation

The bulldozer has been and is still chiefly used for second-operation work, and as the method employed is older, it will be given before going into the present method on the special press now in operation and shown to the right in Fig. 13.

By referring to Figs. 8 and 15, it will be noted that there is accommodation in the fixture for the three punches and dies shown in detail in Fig. 16.

In this tool the work goes through one die at a time, passing in all through three dies mounted in the consecutive seats *B* in the fixture *A*, Figs. 8 and 15. The bottom of the shell is formed at the end of the stroke between the punch end and a bottoming die located at *C*. It will be noted that the punches have a head instead of a thread to hold them in. A 3/4-in. setscrew *D* on top prevents the dies falling out. The cups from the first operation being hot, the operator takes them one at a time

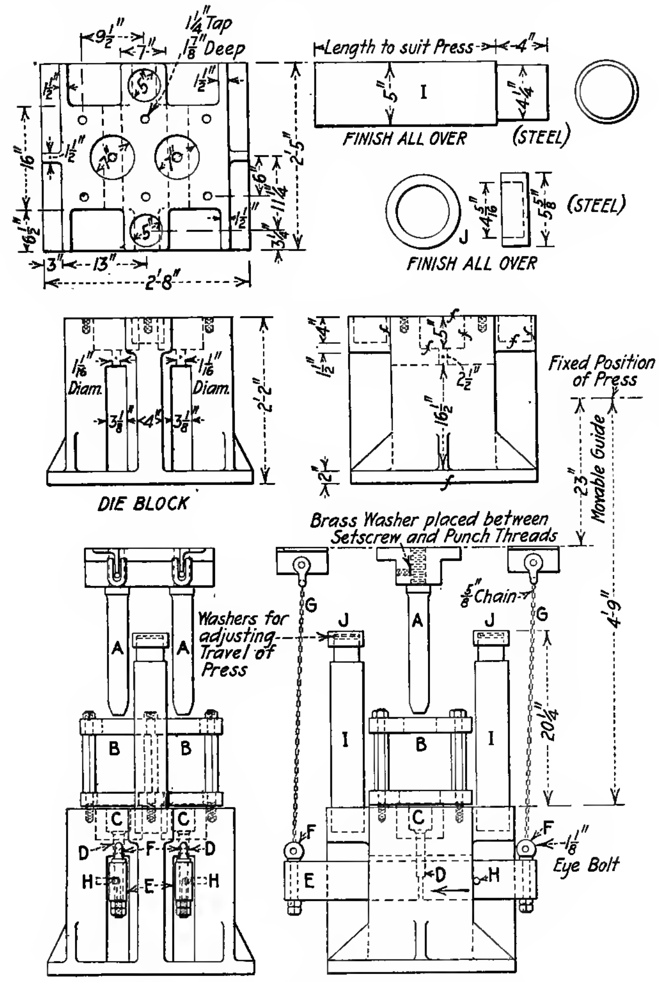


Fig. 14. Shell-Piercing Details

and holds them with the base toward the die. The bulldozer is tripped and the advancing punch enters the hole in the work, pushing it through the die and against the bottoming die *C*. By this time the operator standing on top of the fixture *A* has had time to replace his tongs with a hand stripper which is merely a crotch of steel with a long handle, shown at *E*, Fig. 15. The crotch is placed over the punch between the work and the front flange *F* of the fixture, and on the return of the punch, the work is stripped, dropping to the bottom of the cavity *G*, from which it is removed with tongs.

Second-Operation Forging on Special Press

The second, or drawing, operation on the special press shown to the right in Fig. 13 is entirely different from that done on the bulldozer. There the work passes through three separate operations in three dies held in three different holders; here the work passes at a single stroke through three dies placed in sequence in the same holder. In the bulldozer the bottom is formed inside and the base

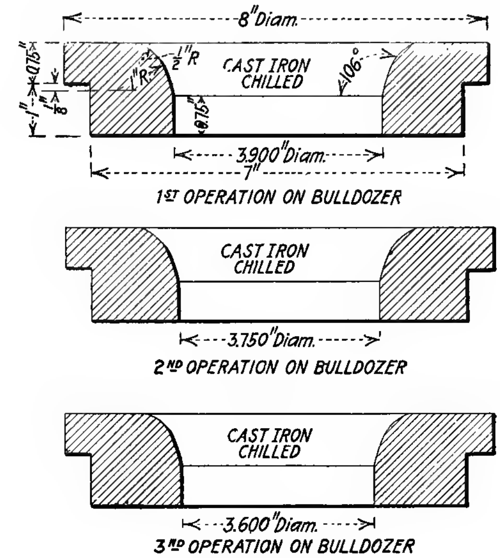


Fig. 16. Shell-Drawing Dies

of the forging brought to the desired thickness at the completion of the stroke. In the special press it immediately precedes drawing, although it does not consist of a separate operation.

The drawing punch and dies are shown in Fig. 17. The arrangement of the three dies, one above the other, the largest at the top and the smallest at the bottom, is shown in the elevation at *H* in Fig. 11 and *T* in Fig. 18.

The Drawing Operation

The cups from the first operation being hot, the pressman at each side of the press removes one from the furnace. On each side is a jet of water, vertically disposed.

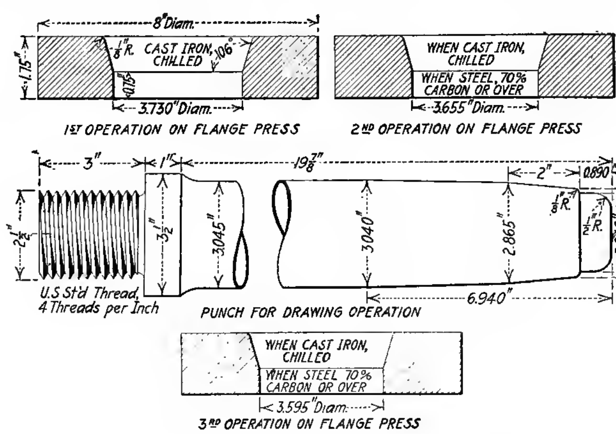


Fig. 17. Drawing Punches and Dies

The cup is inverted over the jet for an instant which causes the scale on the inside to loosen. Striking the inverted cup a sharp blow on an iron block shakes the scale out. Both inside and outside is then scraped and brushed to remove as far as possible the scale. A man on each side of the press then takes a base-forming tool, shown at *F* in Fig. 12, and lays the die end of the tool in the top of the die in the press. The hot forgings are then placed base down in the recess in the top of the base-forming tool, and the press tripped.

On this press two stops are provided, one for forming the base to thickness and the other at the extreme stroke of the ram after drawing has been completed. The first stop is adjustable, and after being used must be swung out of the way before the punch can descend and draw the shell.

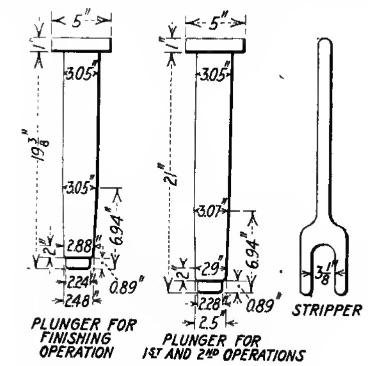
The handling of stops in the large flanging machine, Fig. 2, is by hand, as shown in Fig. 11. Stripping also is by hand, the same as described for the bulldozer operation. There are many objections to hand operation of stops and strippers. There is too much chance of the human equation getting out of balance and too much expenditure of energy. With hand stripping there is always a possibility of spoiling the work or bending the punches by getting the stripper cocked on the edge of an unequally drawn shell. To overcome these difficulties Mr. Allison designed a system of air-operated stops and strippers which entirely obviate any chance of something being forgotten and consequent disaster.

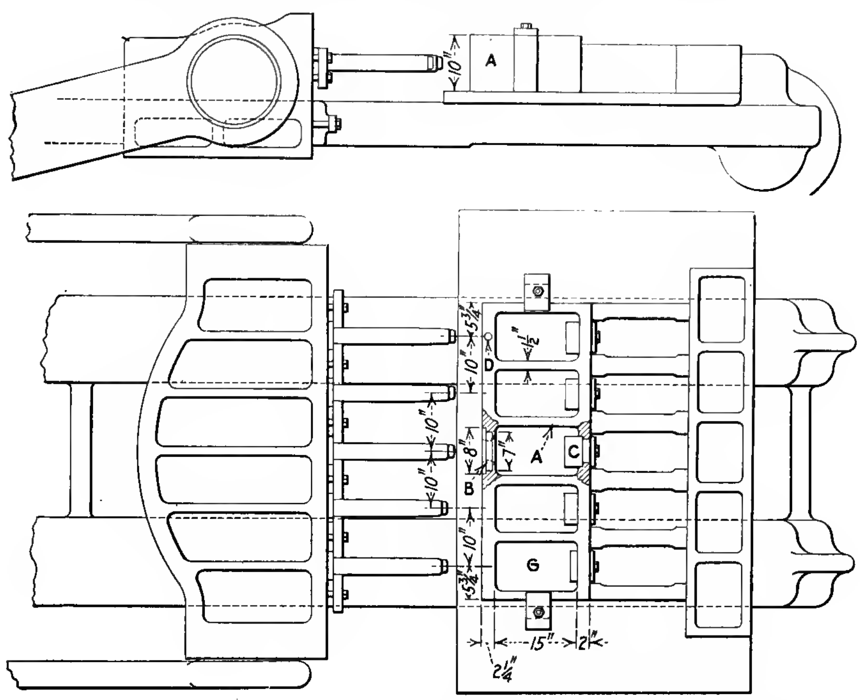
The device is shown in Fig. 18 and is applied to the large Niles press shown to the right in Fig. 13.

Before describing the automatic-stripping mechanism, an outline of the drawing operation as performed without it will give the reader a clearer conception of the duties performed by it and enable him to appreciate its simplicity and effectiveness.

When the first stop is reached, the punches have formed the inside of the shell bases and brought the bases to the desired thickness. The man in control of the hydraulic operating valve raises the punches so that the base-forming die can be removed. In the meantime, the first stops on each side of the press base have been thrown clear of the stops on the ram. The ram is again caused to descend and the punches push the shells down through the three dies, drawing them from 7½ to 10 in. in length. The pressman at each die has in the meantime taken a stripper similar to the one used in the bulldozer and shown at *E,* Fig. 15, and placed the crotch over the punch between the drawn shell (which clings to the punch) and the base of the die seat. On reversal of the ram the forged shell is stripped from the punch and falls to the ground below the die, whence it is removed to a large three-sided iron bin, shown at *A,* Fig. 13.

When things are going right, the press on second-operation work turns out about 70 finished forgings an hour. The work is not only heavy, but must be rapidly performed and, owing to the proximity of the furnaces, the temperature is high.





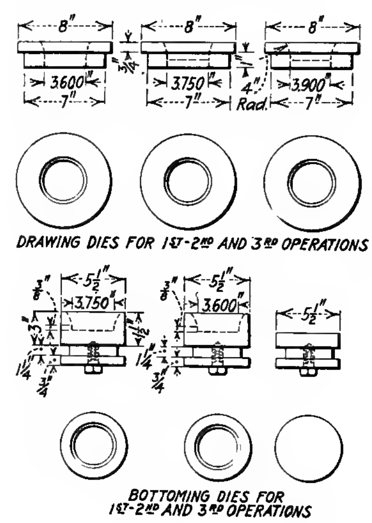


Fig. 15. Bulldozer Equipment for Forging Shells

Automatic Base-Forming Stops and Strippers

Referring to Fig. 18, the stops *A* for the base-forming operation are secured to the plunger plate of the press, one at the front and one at the back. The lower member *B* of the stop, when in operating position, covers a cored hole *S* in the main frame, which is large enough to permit the stops *A* to pass downward when the members *B* are drawn out of the way. The members *B* are in slides and actuated by connecting-rods from the bell cranks *C.* The stop *A* seats in a cup in *B,* in the bottom of which are a number of disk-shaped shims. A slot *D,* which runs through the cup, serves a double purpose, facilitating both the removal of shims and the egress of water, which is apt to fall into the upturned mouth of the cup when the punches are being cooled with the spraying tool shown at *E,* Fig. 12. Before this slot was made the water caused the men much annoyance through squirting in their eyes.

The bell cranks *C* are operated by the air cylinder *E.* The two strippers *F* are actuated by the bar *G,* which has a yoke, or opening, *H* of sufficient size to permit the removal of the stripper for repairs or replacement or the use of a hand-stripper, should that be for any reason necessary. One end of the bar *G* is pivoted through a link to the main body; the other end is connected to the yoke-end *I* on the piston rod of the air cylinder *J*, shown in the upper right-hand corner of the detail. This cylinder receives air at one end only and the piston is returned by the coiled spring *K*, also shown.

At *L* is an air valve which is normally kept closed by a heavy compression spring *M*. The spindle of this valve is embraced by a yoke, the upper end of which finishes in a pin *N* which is in line with a trip plunger, mounted on the plunger plate of the press, which depresses *N* just as the plunger completes its downward stroke. This permits the air under pressure in the pipe *O* to pass through the pipes as shown by the arrows, actuating both pistons in the air cylinders *J* and filling the reservoir *P* (the duty of which will be explained later). The piston in the air cylinders *J* forces the strippers *F* into contact with the punches, and as the press ram ascends, the finished forgings fall to the bottoms of the cored openings *Q* in the base.

In the pipe system is an adjustable needle valve *R*, which permits the air to leak gradually from the pipe system, the air cylinders *J* and the air reservoir *P*, when the valve *L* is in normal, or closed, position. By regulating the leakage through the needle valve *R*, the device can be so timed

descends until the stop *A* brings up against the lower member *B*. The ram is raised to remove the base-forming die and the operator opens the air-control valve. The air entering the cylinder *E* throws both lower members *B* back, so that the stops *A* are free to enter the cored

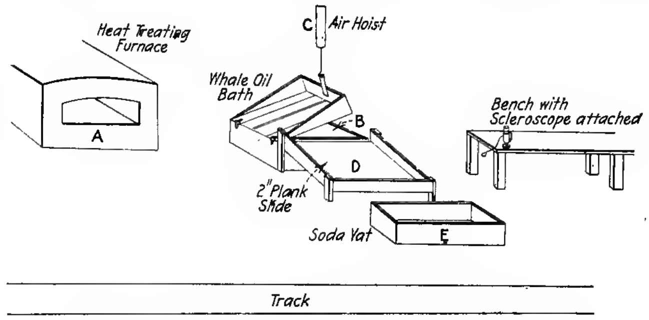


FIG. 20. HEAT-TREATING ARRANGEMENT

holes *S*. The ram, being reversed, comes on down forcing the forging through the triple dies *T*. Near the bottom of its stroke the stripper trip on the plunger plate strikes the plug *N*, allowing the air to enter the stripping system and to actuate the stripping operation as described. While still hot and before being thrown into the

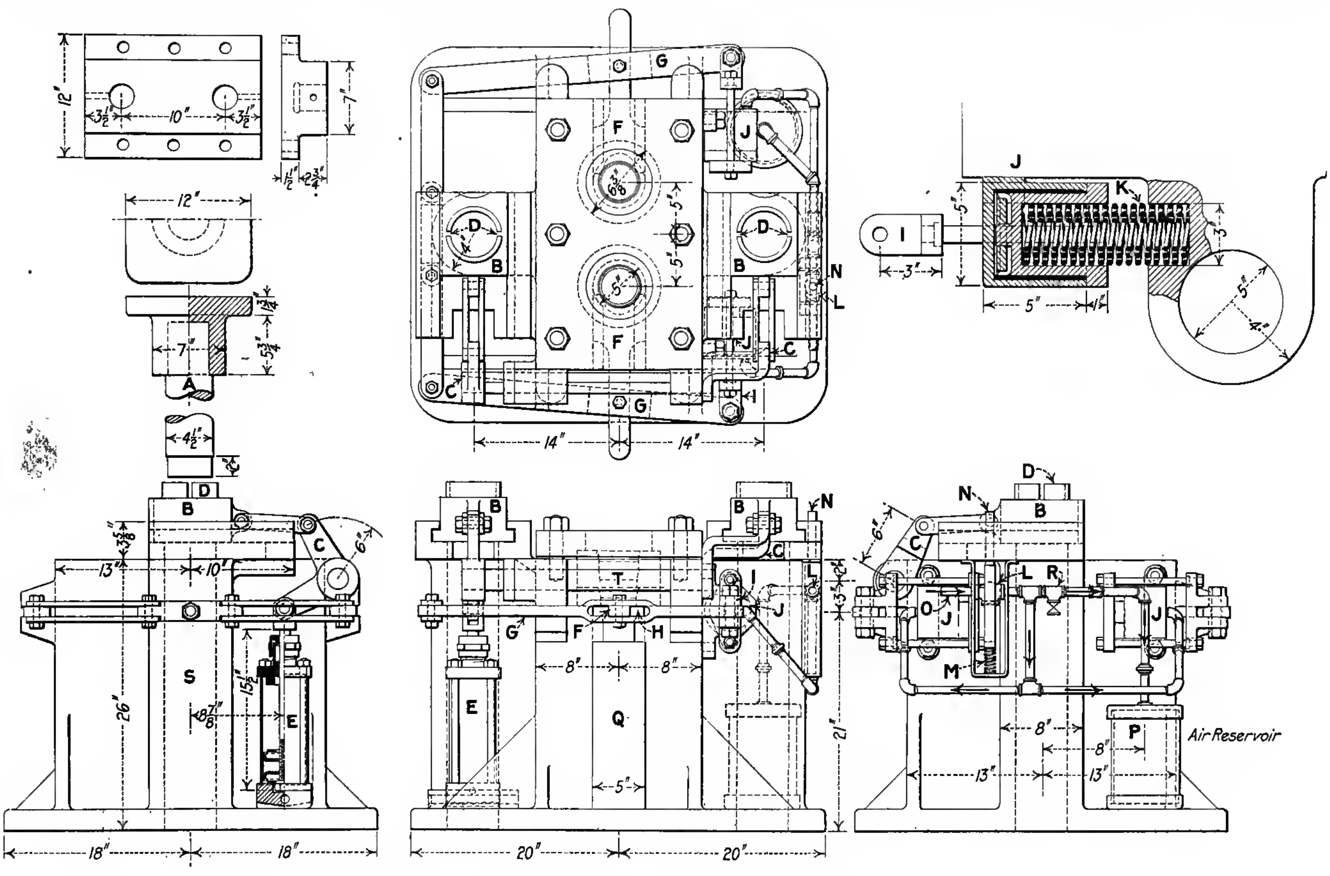


FIG. 18. EQUIPMENT FOR SHELL-DRAWING WITH AUTOMATIC STRIPPERS AND BASE-FORMING STOPS

that, shortly after the finished forgings are stripped from the punches, the pressure in the pipe system and reservoir will have fallen so low that the pull-back springs *K* in the air cylinders act, and the strippers are drawn back where they will on the next stroke of the press clear the descending work.

ACTION OF THE AUTOMATIC DEVICE

Briefly, then, the action of the device is as follows: The work is placed in the base-forming die and the ram

bin *A*, Fig. 13, the forgings are gaged with the forked gage shown at *H*, Fig. 12.

FORGING HINTS

It is most imperative to remove as much of the scale from the work as possible, as this is liable to cause a great deal of trouble cutting the dies and making cavities in the work. Proper lubrication of both punches and dies has been a source of considerable thought. When the job first came up, the old blacksmiths' trick of putting a pinch of soft coal in ahead of the punch was tried, but discontinued. While hot, the hole would look good and clean, but when being machined, pockets of scale and slag would break out and the work would not pass inspection.

At present graphite and water applied with the swabber shown at *G*, Fig. 12, are used on the punches. For the dies, graphite and oil are applied with a similar tool. But there is still much to be desired in the way of a good lubricant.

Correct temperatures are of great importance. For the first forging operation, the work should be as near 2000 deg. F. as practicable; for the second operation, the work should be at a temperature of 1800 deg. F.

Speeds are also of considerable importance. On the first operation, a speed of 30 ft. per min. is permissible and satisfactory; on the second operation, a speed of 22 ft. per min. is all that the work can safely stand, an increase over this of only 2 ft. per min. being liable to cause trouble. A decrease of speed by the same amount also gives unsatisfactory results.

Examples of two of the most common forms of spoiled work from the drawing dies are shown in Fig. 19. The one to the left was probably too thick on the end and bulged out around the base-forming die so that it would not pass through the drawing dies. It may also have been either too cold all over or locally, or there may have been hard spots in it, as indicated at *A*. The one to the right, which pulled in two, has evidently crowded over to one side of the die, as indicated by the ridge at *B*. In spite of all the difficulties, from 70 to 90 per cent. of the forgings pass inspection.

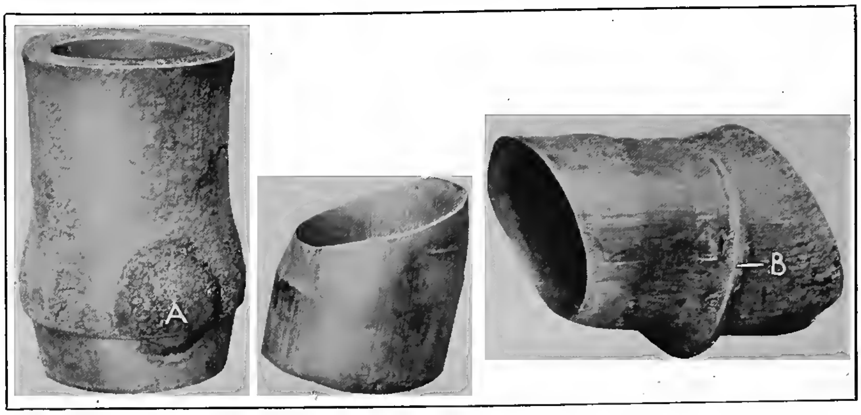


FIG. 19. EXAMPLES OF SPOILED FORGINGS

HEAT TREATMENT

After the forgings are machined, up to the completion of operation 10, as shown in "Making the 18-Lb. British Shrapnel," page 493. They then go to the heat-treating department, shown in Figs. 20 and 21. The shells are placed 30 at a time in reverberatory furnaces *A*. It takes about 30 min. to bring them to a temperature of 1500 deg. F. They are then taken one at a time and quenched in whale oil in the tank *B*, provided with a screen bottom which can be raised by the air hoist *C*, as shown in Fig. 20. After the bulk of the oil has drained from the shells, they are placed on the angular draining surface *D*. After the first treatment, the shells, if too hard, are reheated and drawn at a temperature varying from 700 to 900 deg. F., depending on the steel, to give the required scleroscope hardness of 38 to 42. As previously stated, the heat treatment is determined by Mr. Hendy, the chemist, from the coupons taken from each melt. Of three lots passed through in 5 days, 3000 required no second treatment, while the remaining 12,000 had to be drawn.

After heat treatment the shells are washed in soda water in the vat *E* and are as described in operation 11 of Mr. Van Deventer's article, already referred to. It has, however, been found that bending of the metal in this operation at the low temperature attained by the metal at the point where the curved nose strikes the cylindrical body is apt to make it brittle; so, after nosing, the shells

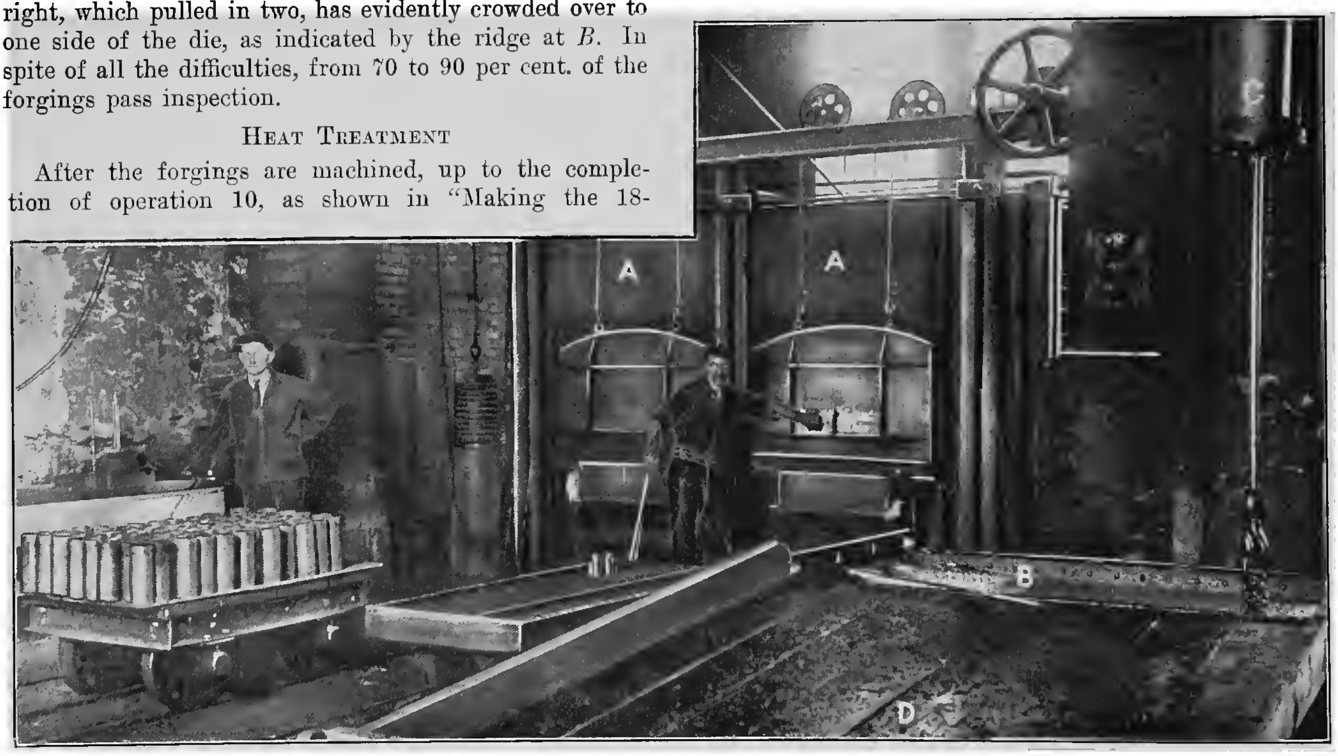


FIG. 21. HEAT-TREATING DEPARTMENT

are returned to the lead pot, shown in Figs. 22 and 23 to bring the metal at this point to a low red heat and prevent shortness.

The pins A are of such length that when the shells

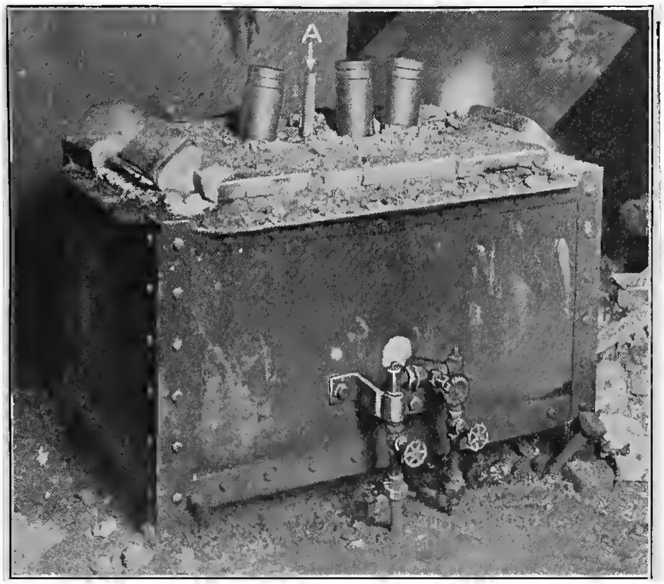


Fig. 22. Lead Pot

are inverted over them the open ends reach down the required distance into the lead.

The nosing die is shown in Fig. 24, at A, and at B is

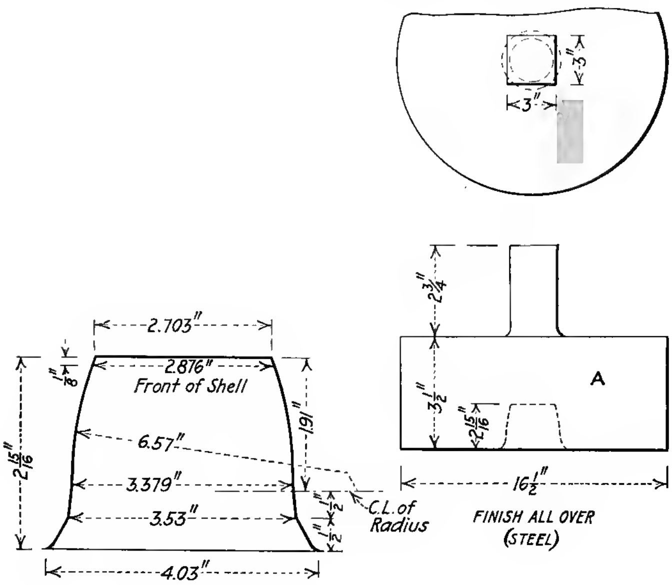


Fig. 24. Nosing Dies

the bolster to locate the base of the shell in line with the die. Formerly, for every 120 shells nosed, there was a wastage of 100 lb. of lead due to evaporation. The present chemist suggested covering the surface with broken charcoal, and now the wastage is about 20 lb. for 500 shells, and the bulk of this is what sticks to the work. In all lead-pot heating, the protection of the surface with charcoal is advisable, as unprotected lead hardens and depreciates rapidly.

If the thin part of the shell, that is, above the line AB in Fig. 25, shows a scleroscope hardness according to specification, the test piece will invariably pull apart in the thick part below the line AB of the test piece. This, of course, is because the heat treatment affects the thin section more readily, and because in this as in all other work the thickness of the work, as well as the hardness, influ-

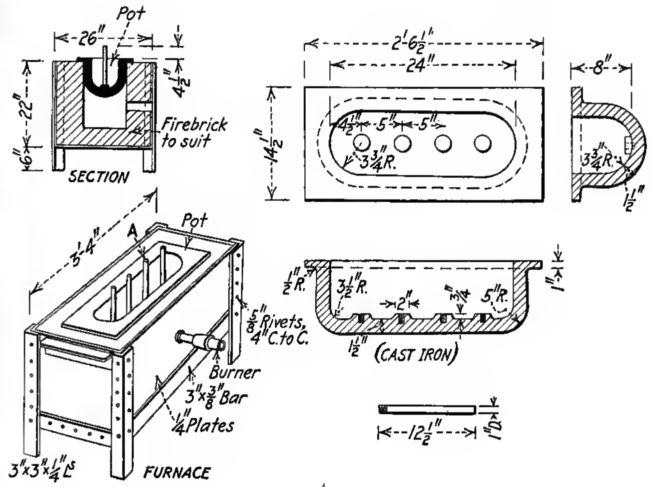


Fig. 23. Lead Pot and Furnace

ences the rebound of the indicating member of the scleroscope.

The scleroscope is mounted on a base and perpendicular to the center of a V for the reception of the shell. At the back of the V is a stop to locate the shell, so that the testing point is always a given distance from the base of

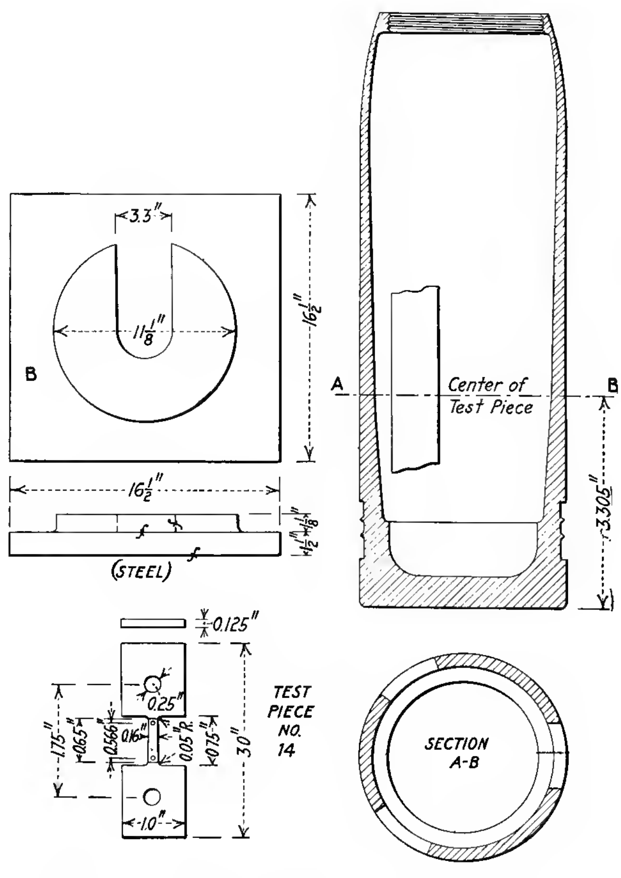


Fig. 25. Location of Physical Test Pieces

the shell. This testing point is slightly below the line AB, Fig. 25.

Manufacturing Shrapnel Parts on Automatic Machines

By J. P. Brophy*

SYNOPSIS—This article describes in detail the operations for producing shrapnel cases, heads, fuse bodies and fuse caps on automatic turret lathes. The rate of production is given for each part, and photographs and drawings of the tools are reproduced.

The most important parts of a shrapnel in time of war are those that take the longest to produce. This fact was very strongly emphasized during the first few months of the present war. In France the government made a search for all lathes which were available for this kind of work, concentrated them in various centers and began to produce shrapnel shells as fast as possible. There is no doubt that other governments are taking similar steps to keep from running out of this important form of ammunition, and, in fact, we have felt the demand somewhat in our own country.

From this point of view, the most important parts of a shrapnel are the case, head, fuse body and fuse cap, and to meet the demand for information on this subject, I will describe the production of these parts on Cleveland automatic turret lathes, which are used quite extensively for this purpose in the arsenals of the United States.

*Vice-president and general manager, Cleveland Automatic Machine Co.

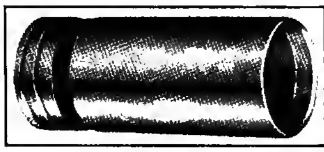


Fig. 1. A Shrapnel Case Produced from the Bar

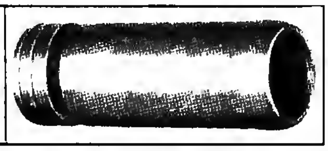


Fig. 2. A Shrapnel Case Produced from a Forging

The Shrapnel Case

The case is the most important part of all, and requires the most time to produce. It is made either from steel forgings or from the bar; in the first instance two chuckings are required, and in the latter only one.

Fig. 1 shows the appearance of shrapnel cases produced from bar stock, and Fig. 2 that of cases made from forgings. Both are shown as they come from the machine.

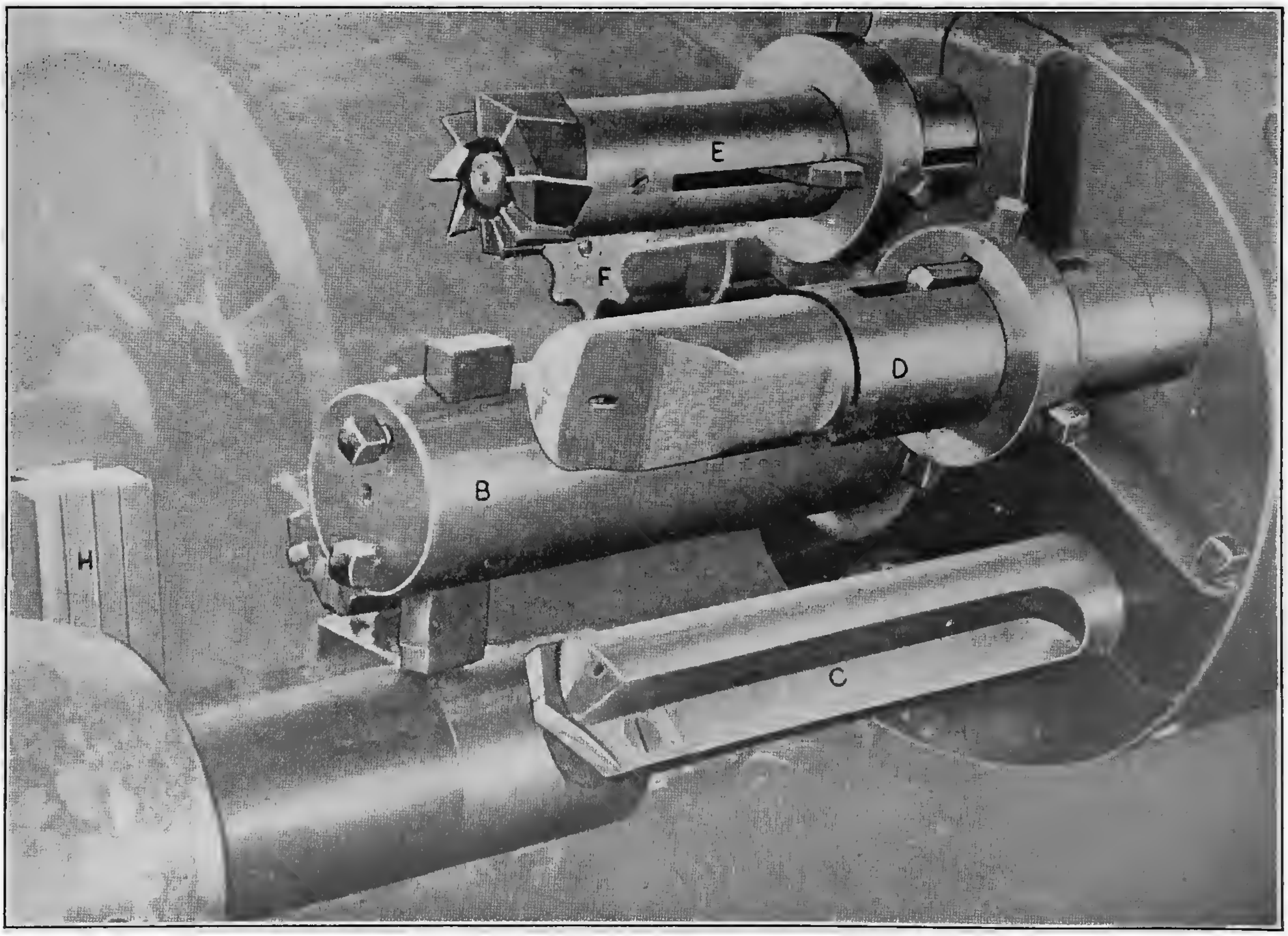


Fig. 3. First Operation in Making 3-In. Shrapnel Cases from Bar Stock

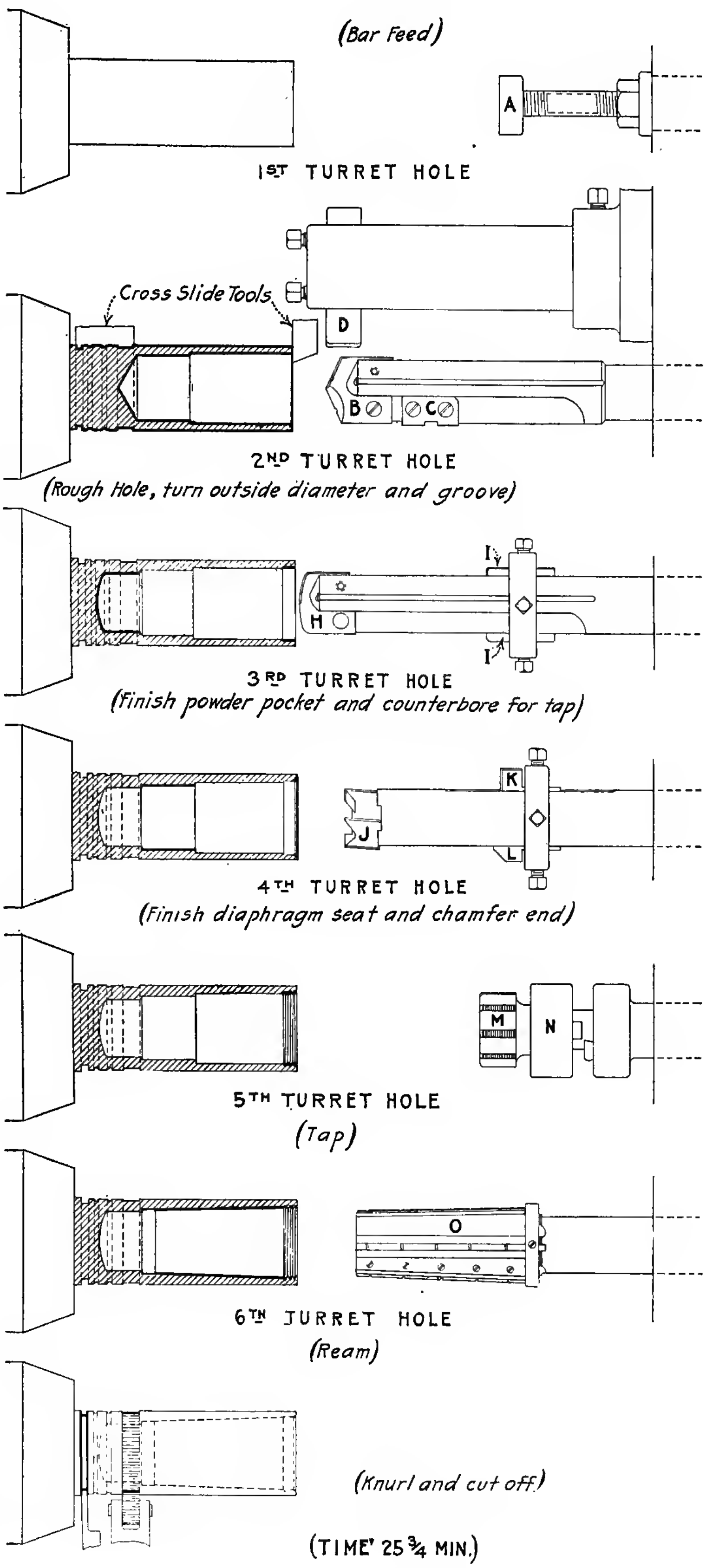


FIG. 5 - MACHINING A 3-IN. SHRAPNEL CASE FROM BAR STOCK

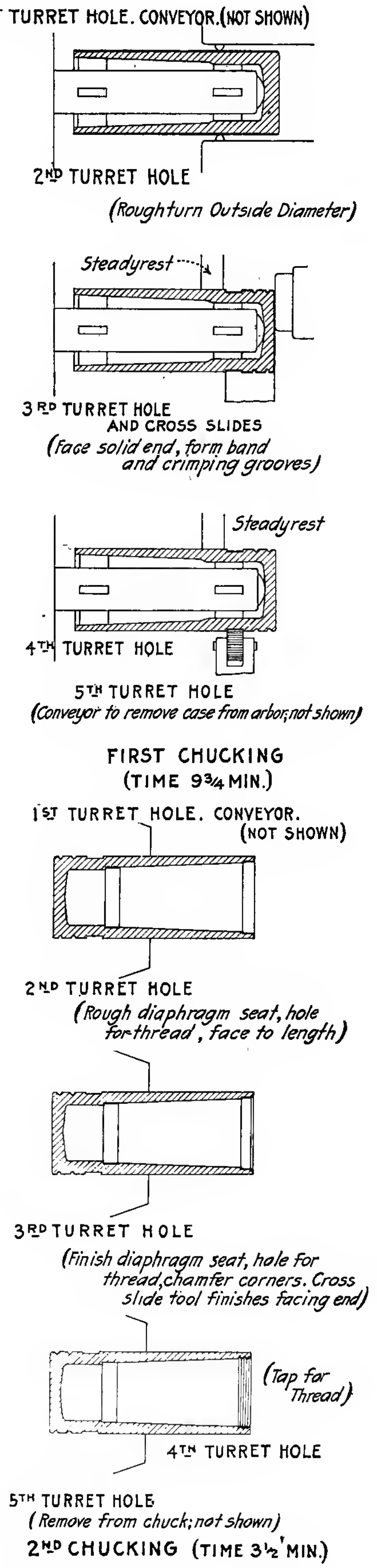


FIG. 6 - MACHINING A 3-IN. FORGED SHRAPNEL CASE

The process of machining 3-in. cases from the bar is clearly shown in Fig. 5. The tool set-up is illustrated in Figs. 3 and 4. The tools in these illustrations are lettered similarly to those in the machining diagram, Fig. 5, as a convenience in following the operations.

The tooling arrangement and operations for producing 3-in. common shrapnel cases from forgings are shown in Fig. 6. The machine upon which this work is done is a 4½ model A Cleveland automatic equipped with a rotary tilting magazine and an air-expanding arbor to grip the forgings on the inside for the first chucking. This arbor is arranged with two sets of jaws, of three jaws each, gripping on either end of the case, and are controlled by a double-acting taper shaft working directly on the jaws. The end of the arbor also serves as a gage stop, as it seats on the bottom of the powder pocket.

After the first chucking, the case is heated and upset at the mouth end before completing the operations in the second chucking.

It will be noted, from reference to the production time for the forged case in Fig. 6 as compared with the case produced from the bar shown in Fig. 5, that there is considerable machining time saved with the forged cases. This, however, does not account for the forging time which must be added to make a true comparison between the two methods.

Shrapnel Heads

Shrapnel heads vary considerably in proportions according to the nominal size. This is indicated in Fig. 10, which shows $3\frac{8}{10}$-in. and 6-in. heads. The tool set-up used in connection with these pieces is shown in Fig. 11.

Shrapnel heads are produced from 20-carbon cold-rolled-steel bar-stock. All operations are completed in one chucking, and are as shown in Fig. 7. An interesting feature in connection with the machining of this piece is the employment of a cross-slide counterboring attachment which gets in its work on the fifth turret position. This consists of a lateral slide mounted in front of the cross-slide and carrying a head with inserted formed cutters. The attachment is operated by a push-and-pull rod in the fifth turret hole. Provision is made for stopping and locking the cross-slide in the proper location for this attachment to operate, this being cared for by an adjustable cam and roll stop, the latter mounted on a block in conjunction with the flat forming-tool post, the stopping cam being clamped on the camshaft.

The two remaining parts of importance are the fuse bodies and the fuse caps. The former are made of bronze

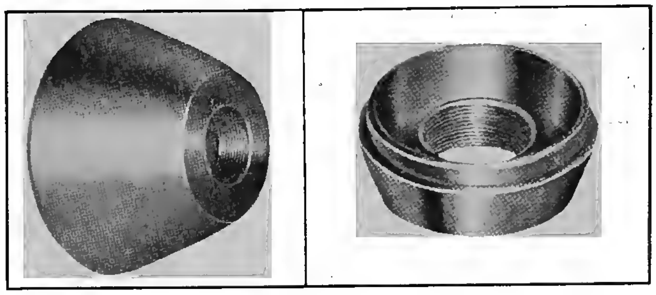


Fig. 10. 3.8-In. and 6-In. Shrapnel Heads

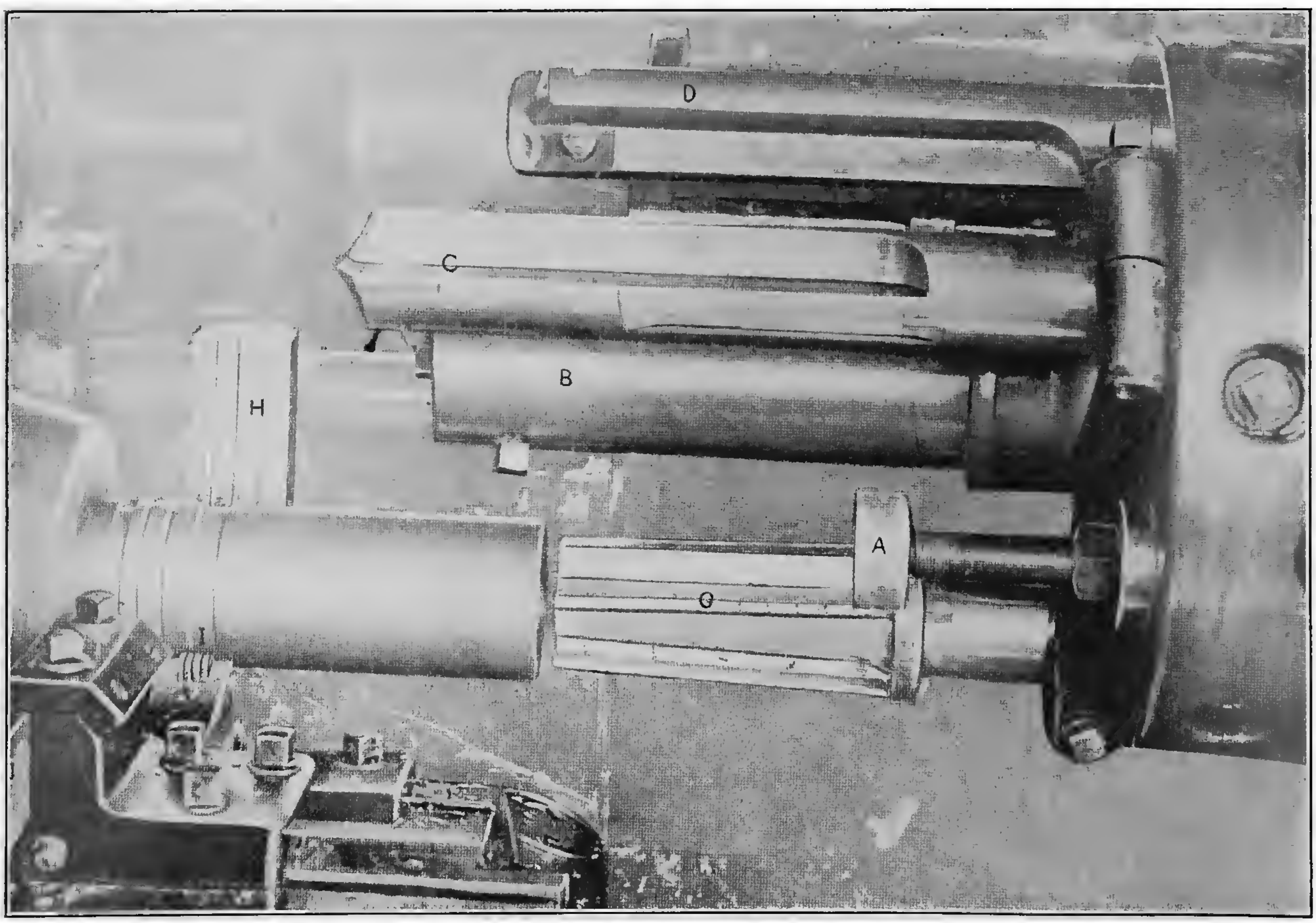


Fig. 4. Last Operation in Making 3-In. Shrapnel Cases from Bar Stock

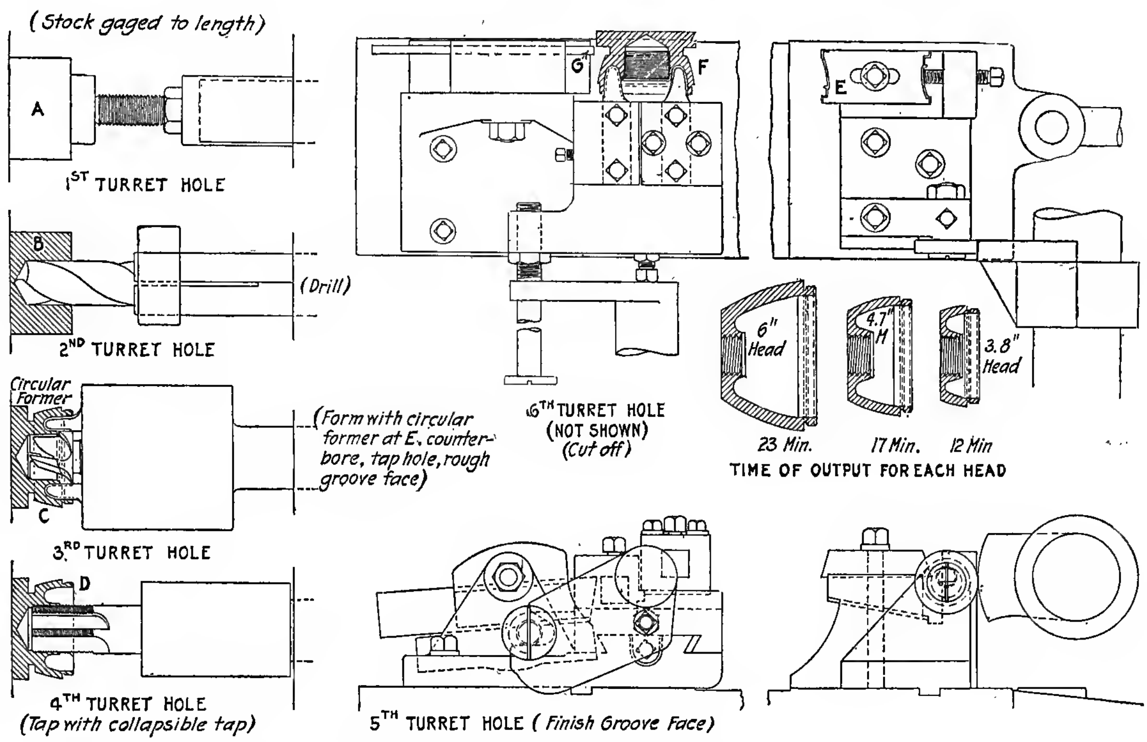


FIG.7- MACHINING A 3.8-INCH, 30 POUND SHRAPNEL HEAD.
(MATERIAL, 20 CARBON, C.R. STEEL. TOTAL TIME 12 MINUTES)

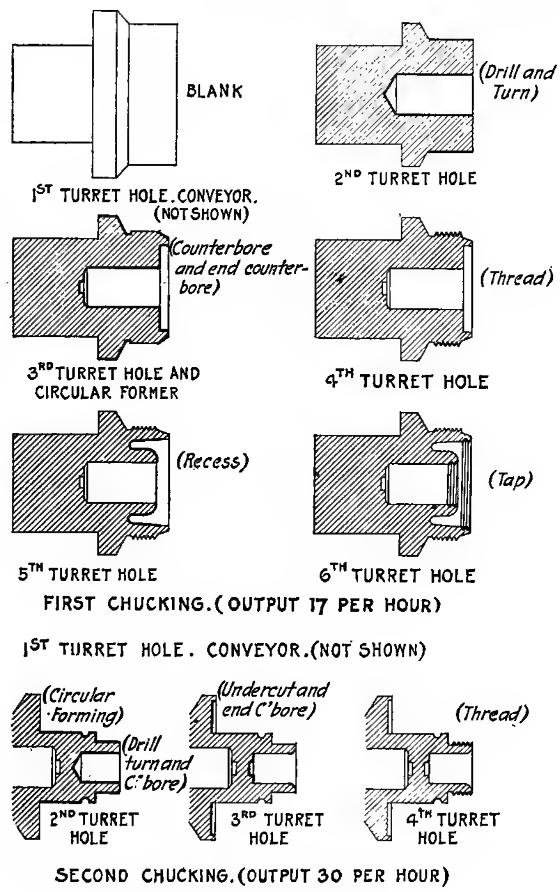


FIG.8 - MACHINING A FUSE BODY.
(MATERIAL, BRONZE STAMPING OR BRASS CASTING)

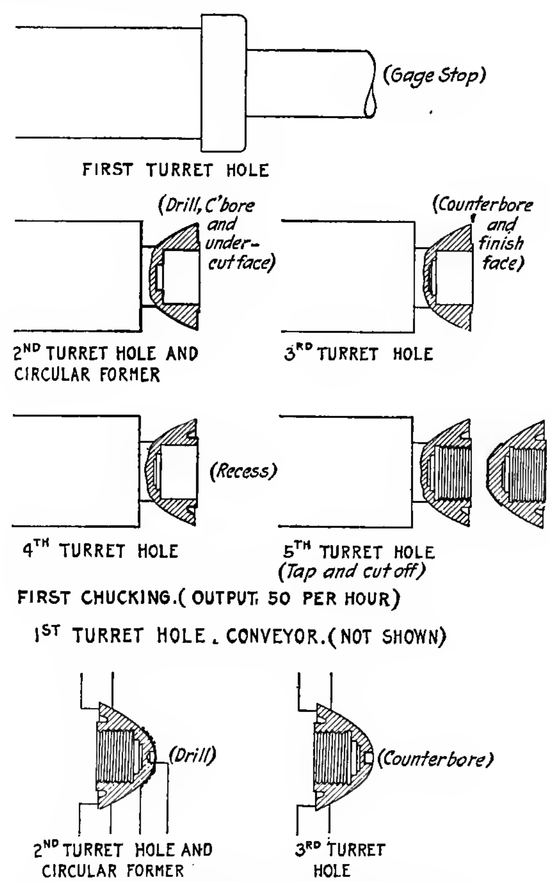


FIG.9 - MACHINING A FUSE CAP (MATERIAL, BAR BRASS)

MACHINING SHRAPNEL HEADS, FUSE BODIES AND FUSE CAPS ON AUTOMATIC TURRET LATHES stampings or brass castings, the latter are machined from bar-brass stock. In handling these parts, a full automatic, equipped with tilting magazine and air chuck, is used as illustrated in Fig. 12. The air chuck *A* is screwed on the spindle in place of the regular chuck hood. It is fitted with three removable jaws, as *B*, which receive pads that are shaped to suit the work handled. A connecting-rod fitted to a piston in the cylinder is attached to the chuck jaws *B*, and the admission of air to either side of the piston, controlled by the camming of the machine, opens and closes the chuck.

The magazine is fitted with a link belt *M*, which has bushings conforming to the shape of the fuse blocks and caps to be handled. When the magazine *L* tilts up after the conveyer *N* has removed the piece, the lever *P* comes in contact with a pin which indexes the link belt and advances the next piece of work.

The fuse body requires two chuckings, both of which are handled by the automatic magazine. The operations on this piece are shown in Fig. 8. The fuse cap in its first chucking is handled in bar form, and in its second chucking is held in the pneumatic chuck and fed by the automatic magazine. The method of machining the fuse caps is shown in Fig. 9.

The method of handling and the sequence of operations are clearly shown in the illustrations.

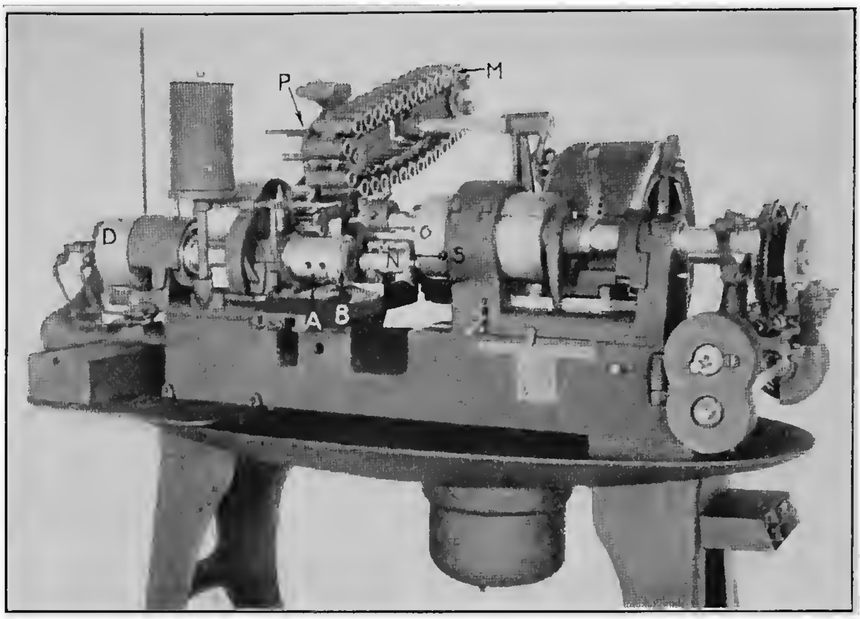


Fig. 12. Machine Equipped with Magazine and Pneumatic Chuck for Producing Fuse Bodies and Fuse Caps

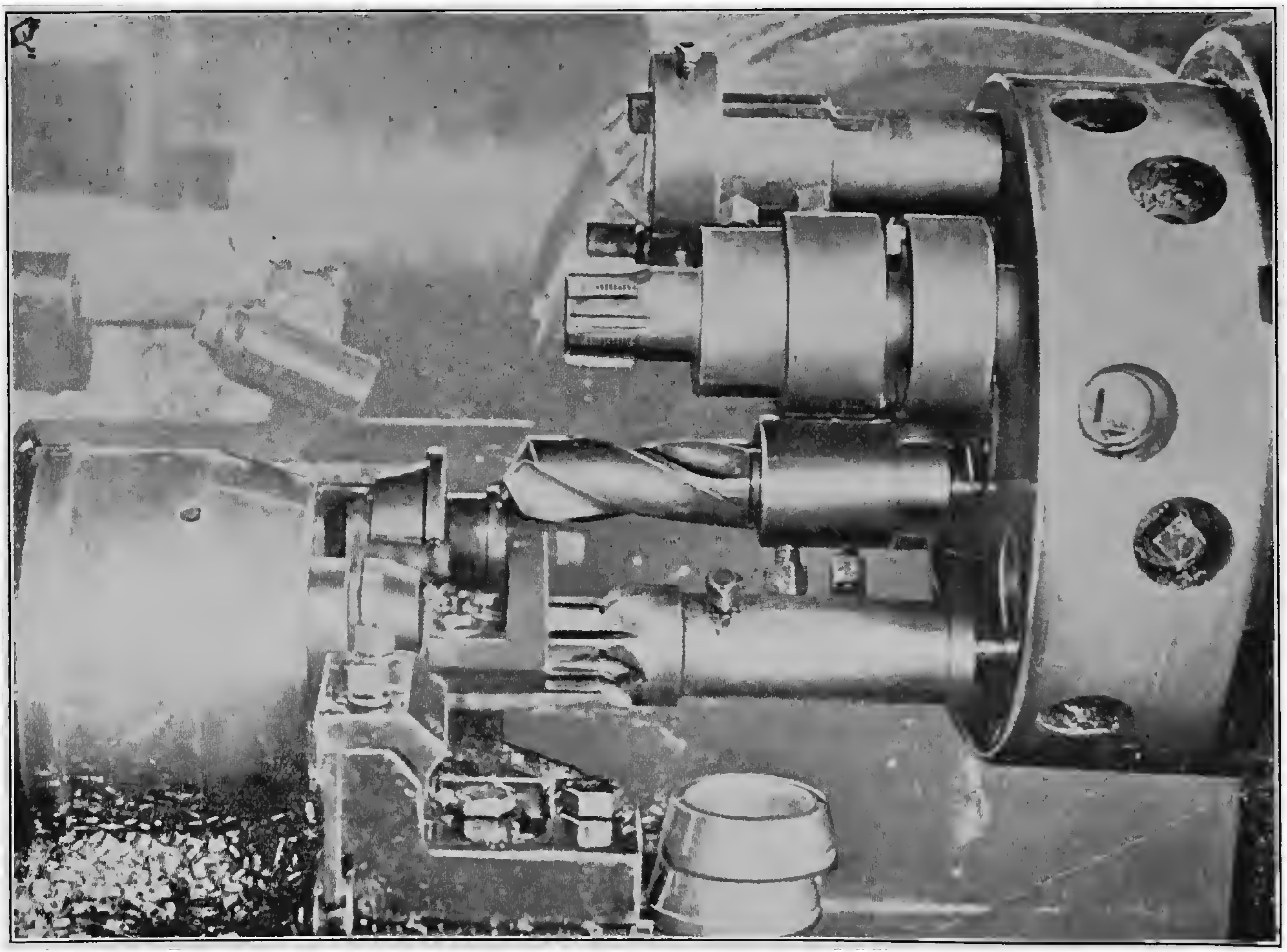


Fig. 11. The Set-Up for Producing Shrapnel Heads on a Cleveland Automatic

Making the 18-lb. British Shrapnel--I

By John H. Van Deventer

SYNOPSIS—Here is a complete exposition of the manufacture of the 18-lb. British shrapnel. Each operation described in detail, including the tooling, chucking, gaging, and production time. The machine tools used are the standard types commonly found in every machine shop, and the extreme subdivision of operations maintained makes their description a basic one.

In time of peace, if you were to approach a manufacturer with the proposition that he completely side-track his regular product and begin at once to make something that he has never seen and seldom heard of, you would, in nine cases out of ten, be answered by an emphatic "Impossible." In spite of the well deserved reputation of the American manufacturer for ingenuity and adaptability, formidable obstacles would pass in mental review. He would see the short time allowed for the complete transformation of his established line; the new product, held at every operation to strict limits of accuracy; the need of a newborn organization, with past training and precedent forgotten, retaining only its inherent skill. It would require a stronger stimulus than that ordinarily offered in times of peace to tempt him to take the risk.

Fig. 1. The 18-Lb. British Shell, from Rough to Finished State

A survey of what Canadian manufacturers have been doing within the last few months forcibly proves that we never know what we can do until we have to do it. The tremendous demand for war materials made itself felt throughout all of the British possessions almost simultaneously with the outbreak of hostilities. The Government arsenals could not begin to supply more than a fractional part of the shells required to keep the field guns in operation. It was absolutely necessary that Canadian manufacturers devote themselves at once to this new line of work. The matter was put into the hands of a shell committee, consisting of military officials and the active managers and owners of Canadian machine shops. As a result, over 130 machine shops in Canada are now engaged in making shrapnel or parts composing them. And the strange part of it is this—without previous experience and in many cases with mechanical makeshifts far from the best, many of these shops have, under the unusual stimulus of war, succeeded in this comparatively short time in making shells at a production rate that compares favorably with the Government arsenals.

The Predominance of the 18-Pounder

For the reason of a maximum damaging ability combined with a minimum of labor of handling both the gun itself and its ammunition, the 18-pounder, which corresponds to a 3.3-in. diameter, is at the head of the list, seconded by the 15-pounder, which is 0.3 in. less in diameter. Of the two sizes, the first is preferable from a manufacturing viewpoint, being small enough to be within the capacity of ordinary machine tools and large enough to allow the boring bars and other equipment to be made suitably rigid for heavy cuts. While this article deals specifically with the 18-pounder, the same operations are used in machining the 15-pounder, which is held within corresponding accuracy limits.

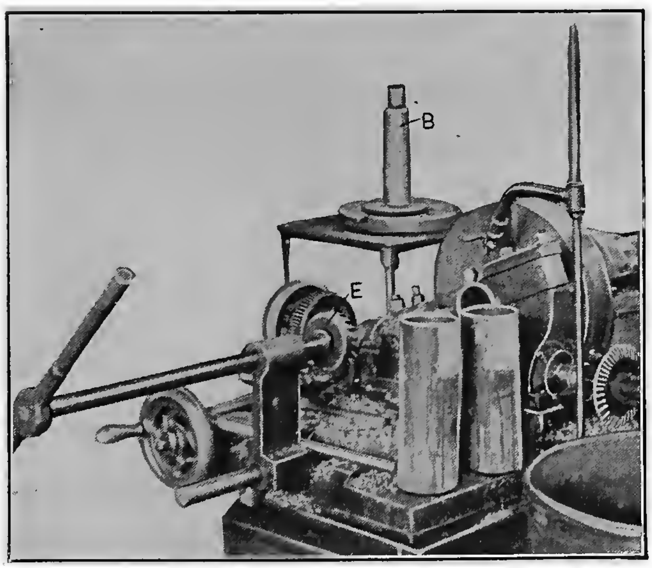


Fig. 2. Cutting Off and Reaming

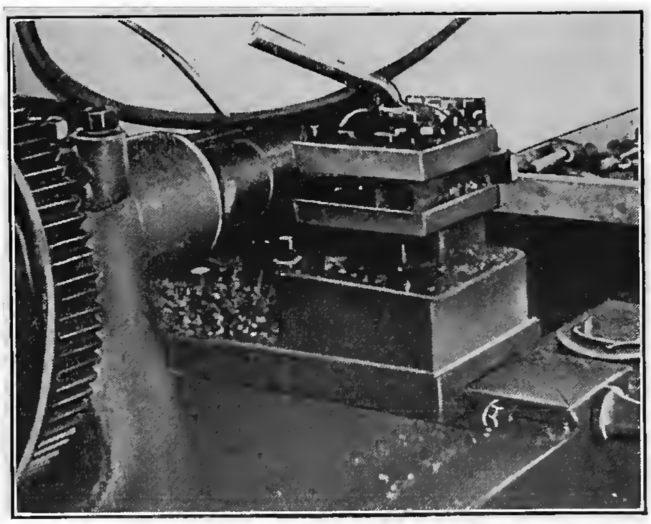


Fig. 3. Rough-Turning the Body

The Canadian Ingersoll-Rand Co. was among the first to offer to deliver a certain number of shells per week, in conformity with the distribution of work made by the Canadian Shell Committee. It should be mentioned that it is one of the few shops that has not delivered slightly under the rated quota, which, in this case, started with 2000 shells per week and gradually increased until

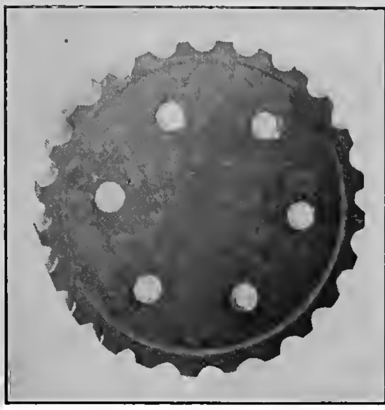


FIG. 4. ROUGH-FACING JIG FOR THE BULLARD MILL

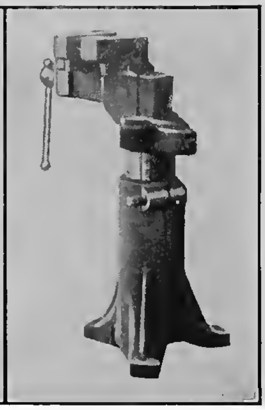


FIG. 5. TYPE OF VISE USED AT THE CANADIAN-INGERSOLL-RAND CO.

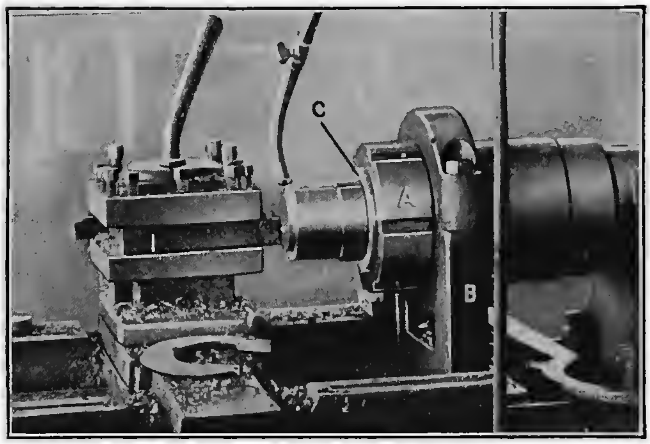


FIG. 6. FINISH-FACING THE BASE AND TURNING THE BASE TO SIZE

now it is over the 3000 mark. Possibly the most interesting part of this to the mechanic is the fact that it has been done without special or automatic machines, chiefly by extremely well planned tooling and first-class shop management. In fact, only one machine tool has been added to the equipment at this plant since it started to manufacture shrapnel.

In speaking of shrapnel in this article, the word is taken to mean the steel case containing the lead balls which are credited with so much destructiveness on the field of battle. These are shipped to England at present without the brass cartridge cases containing the impelling powder charge or the fuse which regulates the time of explosion after the shell leaves the gun. The bursting charge is not added to the shell until it has been received on the other side, although it is completely filled with balls embedded in rosin before it leaves the factory.

CHANGING FROM MILLERS TO DISCARDED LATHES

The Canadian Ingersoll-Rand Co. normally manufactures a line of compressed-air machines, including air drills, chipping hammers, air compressors, and mining machines. The requirements of this kind of work led to the adoption of a large number of millers, especially during the last two or three years, during which time a large amount of work was transferred from turret lathes to machines of this type. In fact, at the time the war broke out, a number of engine and turret lathes were standing idle, many of them on the company's "for-sale" list, to be disposed of when opportunity offered.

Today one observes an exactly opposite condition. The millers are standing idle and the discarded lathes take a prominent place in the foreground of activity, for the manufacture of shrapnel is essentially a turning proposition.

RECONSTRUCTED ENGINE LATHES

An advantage which this plant already had was the possession of a first-class toolroom. The tooling-up for a proposition that runs into hundreds of thousands of pieces is vitally important, for every cent nipped off of an operation means a thousand dollars or more. As a result of this, one finds many reconstructed engine lathes fairly well disguised by the addition of special chucks, revolving

FIG. 7. BORING ON THE FLAT TURRET

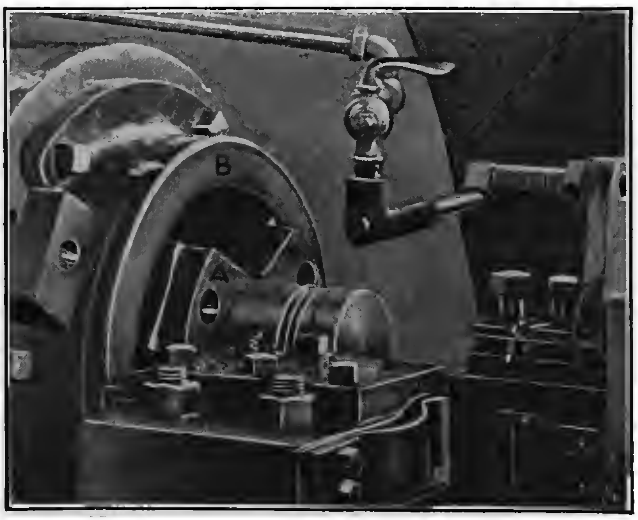


FIG. 8. PRODUCING THE WAVE ON A P. & J. AUTOMATIC

turrets, or square-turret tool posts of the Gisholt type. Their builders would hardly recognize them. But where the original machines, as a general utility tool, had a possible average of 40 to 50 per cent. efficiency, the reconstructed machines with their specialized attachments probably figures nearer to 80 or 90 per cent., from a viewpoint of doing what they have been designed to do. Even the addition of a square-turret tool post to an engine lathe, in cases where the same tools are used over and over again in sequence, cuts down the loss of time very noticeably.

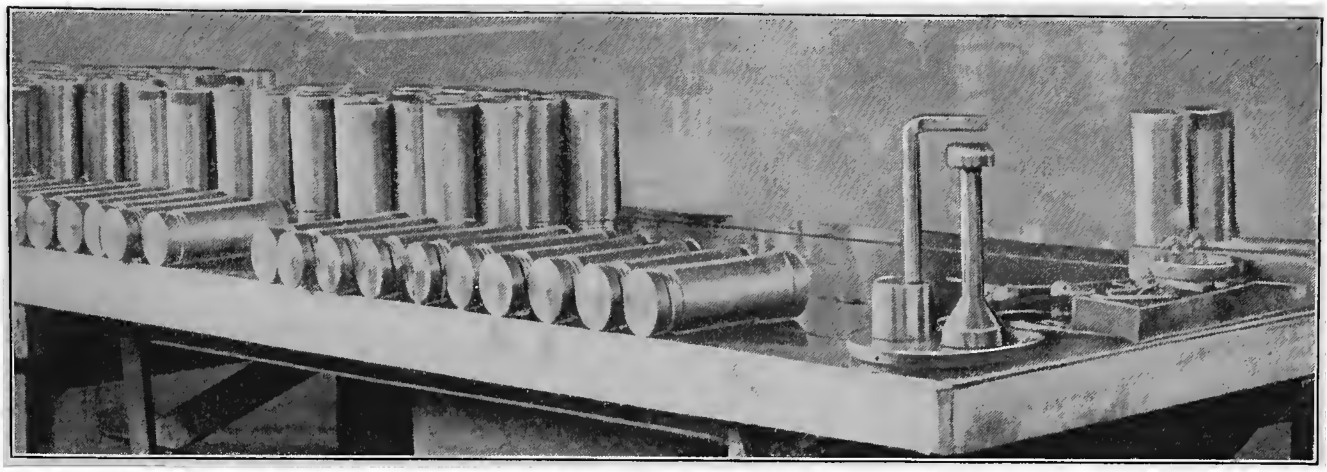


Fig. 9. Table for the Second Shop Inspection

Here one finds an illustration of good work done on old tools. Possibly the most important part of the entire shell, as far as the limit of accuracy is concerned, is the thickness of wall directly behind the thread seat at the nose end. While other dimensions have high and low limits, this particular one is marked simply by the exact dimension, and the slightest deviation shown by the inspector's micrometer from this dimension, causes the rejection of the shell. One of the machines used for performing the operations on this part is an old turret lathe so inaccurate that it had the reputation of not being able to hold a size within one-eighth inch of any given dimension. But when equipped with a positive turret-locking device and a cam which controlled the movement of the cutting tools, the machine was able to live down its former bad reputation and is today producing work fully up to the exacting requirements.

Various Kinds of Chucks

One of the first considerations, and a very important one, is the method of chucking the shell. The requirements are firm gripping and complete and rapid self-centering. The internal chuck used for the second operation presents the most difficult problem. With a restricted space in which to act, and its dimensions limited by the inside of the rough shell, it has nevertheless to withstand the most severe cutting strain of any during the whole process. The details of this chucking arbor are shown on the second operation sheet, and that it serves its purpose may be judged by the fact that a rough cut $\frac{3}{16}$ in. deep and with a $\frac{1}{8}$-in. feed is taken over the shell at a speed of 70 ft.

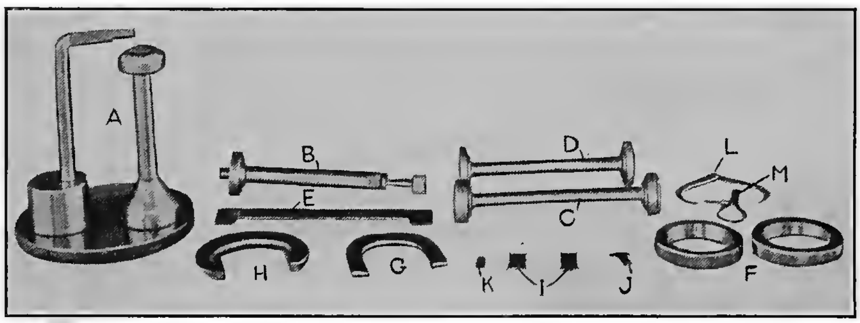


Fig. 10. Gages for the Second Shop Inspection

The external chucking of the shell is a simpler proposition. Various types of chucks are being used for this purpose. The hinged chuck shown in operation 6 was one of the first put in service, but was not altogether satisfactory, as slight variations in the diameter of the shell,

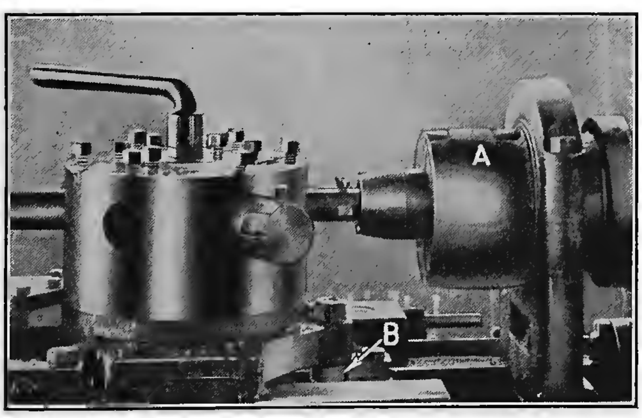
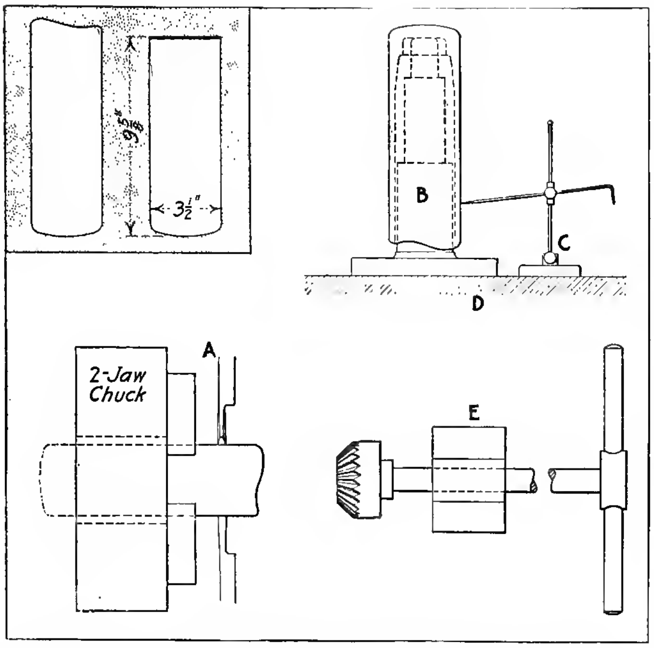


Fig. 11. Turning and Boring the Nose After Heat Treatment

Fig. 12. Type of Truck Boxes Used for Shop Transportation



OPERATION 1. LAY OUT. CUT OFF AND REAM BURR

Machines Used—Cutting-off machines with front and back cutting tools, A.

Special Fixtures and Tools—Mandrel for laying out, B; surface gage, C; surface plate, D; bevel hand reamer for removing burr (held against rotating shell), E.

Gages—None.

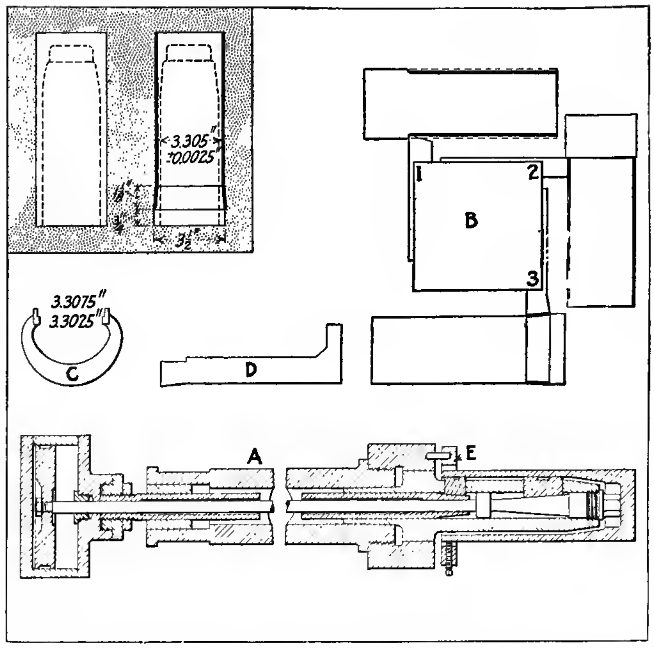
Production—From one machine and one operator, 20 per hour, including laying out.

Note—Soap-water lubrication used in cutting.

Reference—See halftone, Fig. 2.

OPERATION 2. ROUGH-TURN BODY AND TURN BEVEL

Machine Used—Gisholts and engine lathes fitted with turret tool-posts.



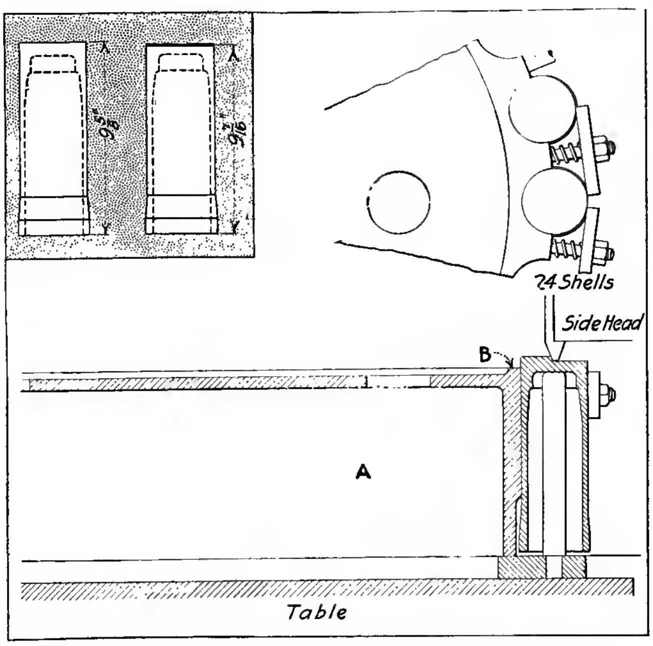
Special Fixtures and Tools—Expanding mandrel, A; special driving dog, E. Cutting tools: For rough-turning body, B1; for finish-turning body, B2; for forming taper, B3.

Gages—Limit snap-gage for diameter, C. Gage for setting taper-turning tool (used against mandrel before shell is chucked), D.

Production—From one machine and one operator, six per hour.

Note—The accuracy of finish of the body at this stage is on account of future chucking in special chucks.

Reference—See halftone, Fig. 3.



OPERATION 3. ROUGH-FACE BASE END OF SHELL

Machine Used—42-in. vertical turret lathe.

Special Fixtures and Tools—Circular chucking fixture to hold 24 shells, A.

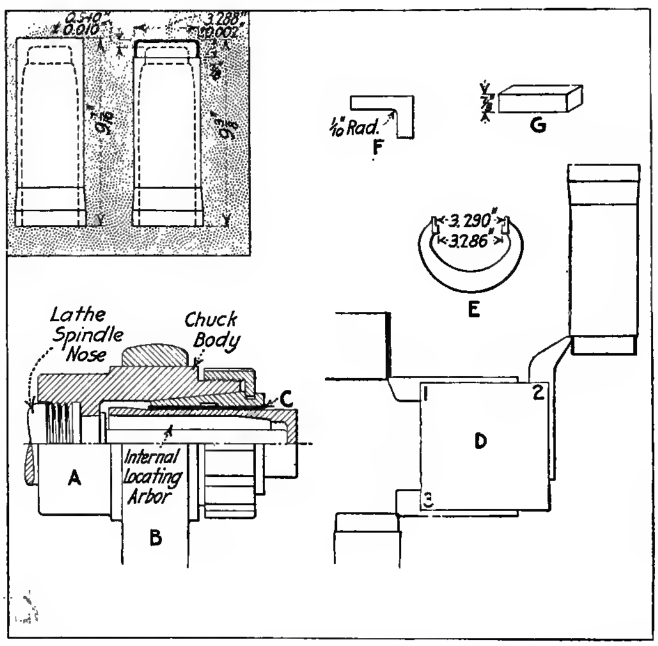
Gages—Thickness gage, ⅝ in. square, for setting tool at correct height in connection with finished surface B.

Production—From one machine and one operator, 48 shells per hour.

Reference—See halftone, Fig. 4.

OPERATION 4. FINISH-FACE END, FINISH-TURN BASE AND MAKE RADIUS ON BASE EDGE

Machines Used—16-in. turret lathes and engine lathes with square-turret tool-posts.



Special Fixtures and Tools—Split-collet chuck, with internal distance arbor, A; steady-head for supporting the collet chuck, B; split adapter bushing, to make up for taper end of shell, C. Cutting tools: For finish-facing base, D1; for finish-turning base, D2; for rounding corner, D3.

Gages—Limit snap-gage for base diameter, E; radius gage, F; distance block for setting facing cut from internal distance arbor, G.

Production—From one machine and one operator, 10 per hour.

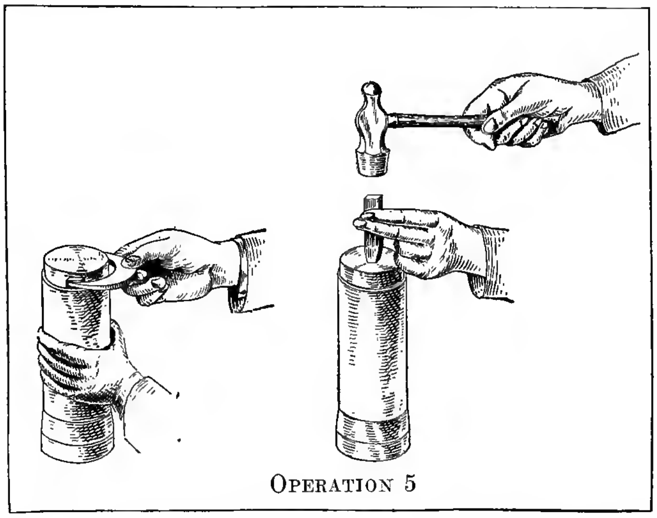
Note—The completion of the base end at this operation eliminates one operation on the grinders.

Reference—See halftone, Fig. 6.

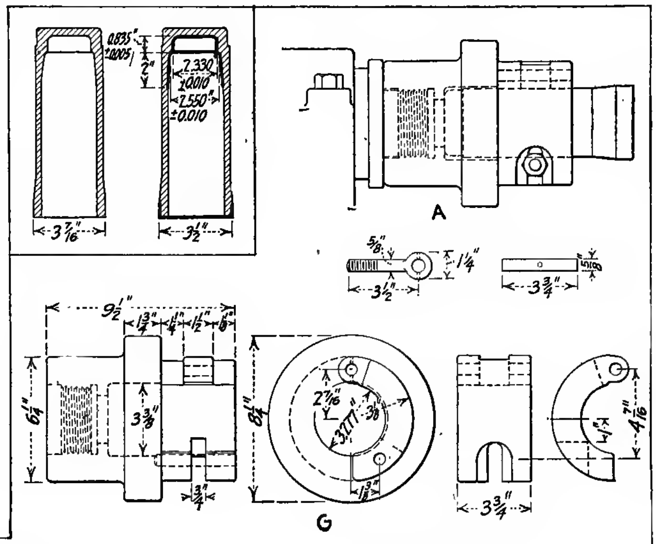
even within permissible limits of accuracy, made considerable difference in holding power. Split-collet chucks, as shown in operations 4, 21 and 27, have proved more satisfactory. The latest improvement is to equip several of these chucks with draw-in collets operated by compressed-air pistons, which effects a creditable economy in the time of chucking. It will be noticed that in nearly all cases the special chuck is equipped with a "steady-head," which is necessary to avoid spring due to the length of the shell.

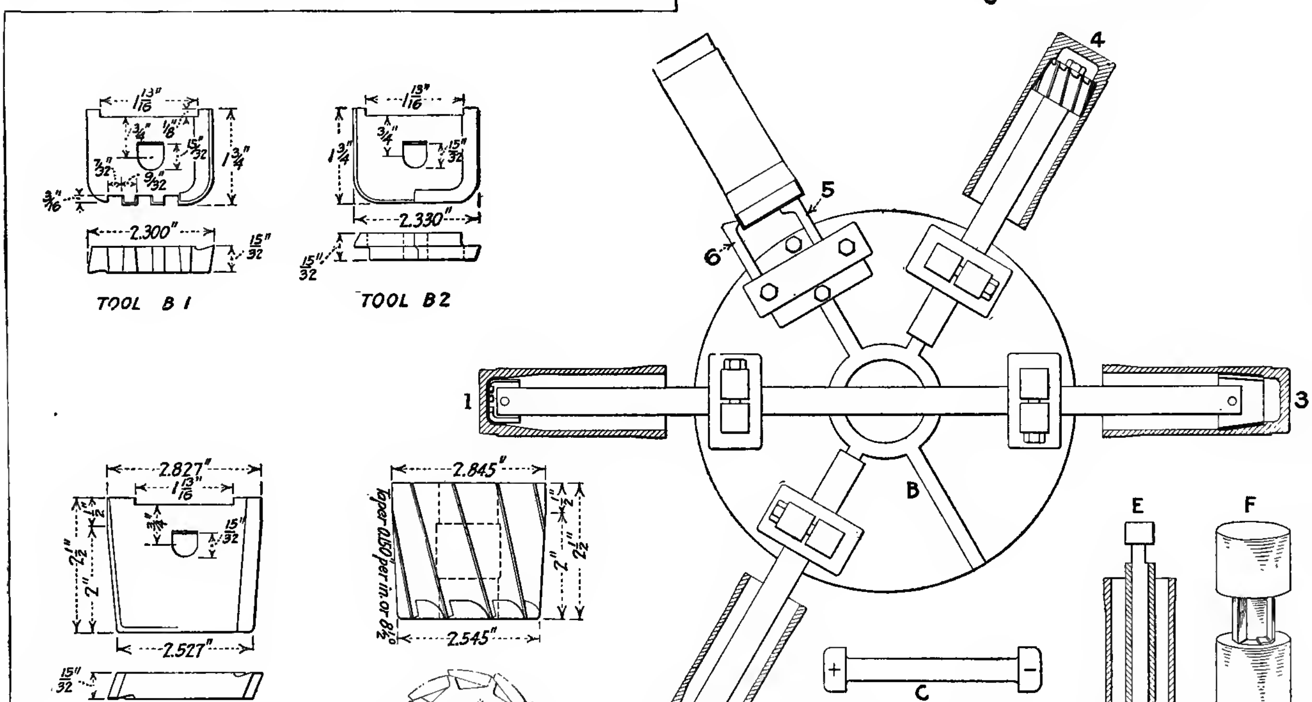
The Advantages of Subdivided Operations

There are two widely different principles in quantity manufacturing, each of which has its apparent advantages and supporters. These are nowhere any better illustrated than in the manufacture of shrapnel shells. Some believe



Operation 5





OPERATION 5

First Shop Inspection—The cases are inspected for size of base diameter, radius of corner, etc., using gages similar to those in the operation 4. The carbon content is also stamped on the shell base at this point, shells being put through in lots of the same carbon content. Up to this point the various lots were distinguished by paint marks inside the shell. At this inspection particular attention is paid to defects and flaws, especially at the base of the shell, so that further labor will not be put on defective cases.

Production—Sixty per hour per inspector.

OPERATION 6. BORE POWDER-POCKET AND DISK-SEAT, ROUGH-TURN AND FACE NOSE END

Machines Used—J. & L. flat-turret lathes.

Special Fixtures and Tools—Special hinged chuck, A. Cutting tools: For rough-boring powder pocket, B1; for finish-boring powder pocket, B2; for rough-boring disk seat, B3; for reaming disk seat, B4; for facing nose end, B5; for turning nose end, B6.

Gages—Double-end limit plug-gage for diameter of powder pocket, C; double-end limit plug-gage for diameter of disk-seat, D; special limit gage for depth of powder-pocket, E.

Production—From one machine and one operator, 10 per hour.

Note—1. Lard oil is used on this operation as a cutting lubricant. 2. Upper end of gage E, illustrating register of + and — surfaces, shown at F. 3. Details of hinged chuck, shown at G.

Reference—See halftone, Fig. 7.

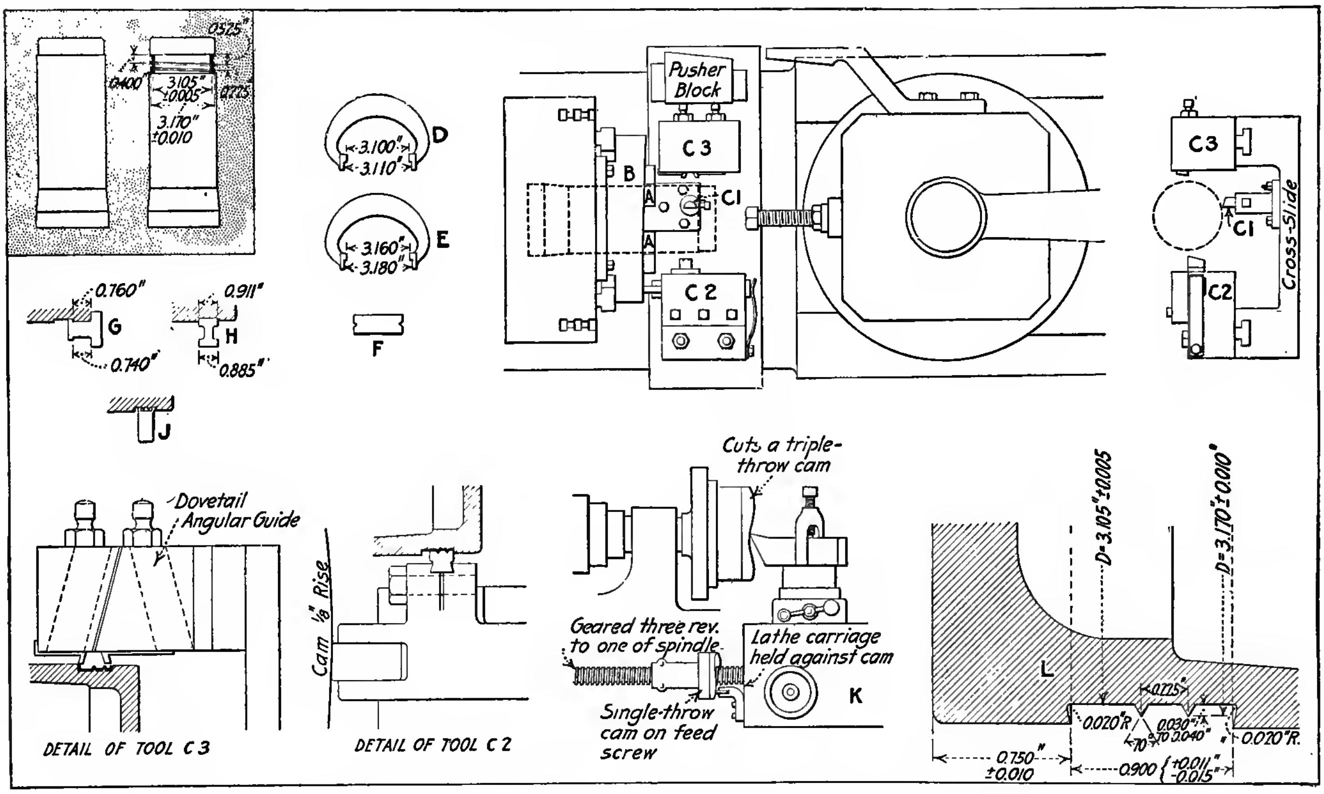
in putting as many operations as possible upon one machine; others, in reducing each operation to its lowest terms. The Canadian Ingersoll-Rand management advocates the latter. It produces several arguments in favor of this plan, in addition to the final proof of a remarkably low total-production time.

"When you multiply operations, you multiply trouble," says Mr. Sangster, plant superintendent. "You have more trouble in making an expert operator out of a green hand, and the delay is more serious in case anything goes wrong. Taking all in all, the flexibility and freedom from serious delays accompanying fine subdivision of operation more than make up for the slight extra cost of handling pieces from one machine to another." It may be possible that this simplification of operations has something to do with the quickness with which this organization has taken hold of a new line of work. Each man has a simple and definite task to accomplish, and his work presents a problem which is not made difficult of solution by containing too many variable and unknown quantities.

Delay at the Start

While the progress made in this new line of work is really remarkable, considering the short space of time at the disposal of the Canadian manufacturers, considerable unnecessary though unavoidable delay was occasioned in securing the first sets of gages. Shell manufacture is strictly a limit-gage proposition, and to go about it properly requires, in addition to the master set of gages used for reference purposes, a set of inspection gages and corresponding gages at each machine for each inspected operation. Since there are over 40 inspections on a shell, the gage question is quite a serious one. The Ingersoll-Rand Co. placed their initial order for gages with a New England concern, which was already up to its neck in similar orders, and the delivery of these gages, which were necessary before manufacture could be started, was delayed for several weeks.

Most of the gages are of the "snap" type, having maximum and minimum measuring surfaces on the same gage. One of the most ingenious is shown in operation 8 at *B*. This is used to measure the depth of the powder pocket. The inner gaging spindle slides within the outer reference sleeve, and is provided with a notch milled at its upper end, with two surfaces, one plus and one minus. The inspector, by grasping the outer sleeve and placing his thumb on the notch, can readily feel the register of maximum and minimum surfaces with the outer sleeve and perform his inspection without the necessity of looking at the gage.



OPERATION 7. CUT RECESS AND MAKE WAVES

Machines Used—P. & J. automatic chucking machines.

Special Fixtures and Tools—Special chuck, jaws bored for shell diameter, A; wave cam, attached to faceplate, B. Cutting tools: For roughing recess (carried on cross-slide), C1; for forming wave (carried on cross-slide), C2; for undercutting recess (carried on cross-slide and fed by arm on turret), C3.

Gages—Limit snap-gage for bottom of groove, D; limit snap-gage for diameter of top of waves, E; template for height and form of wave, F; limit gage for distance of recess from base, G; limit gage for width of recess, H; minimum limit gage for undercut, J.

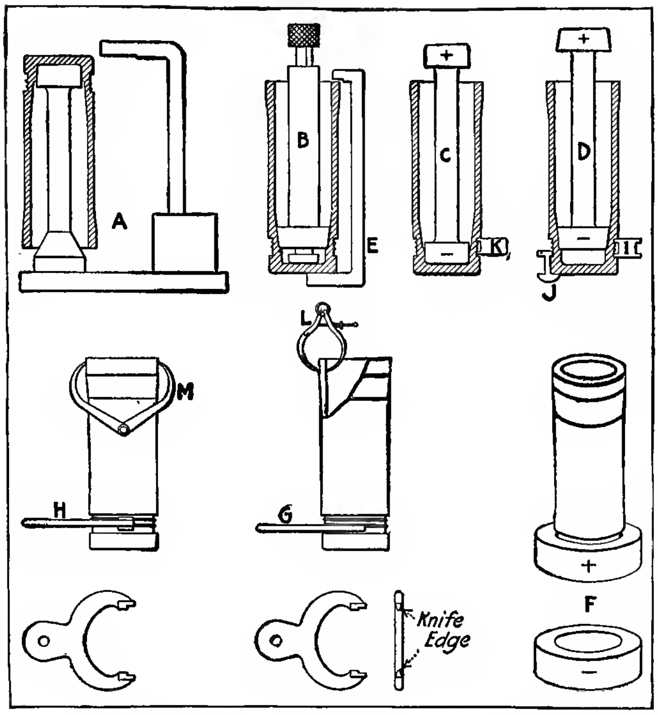
Production—From one machine and one operator, 10 per hour.

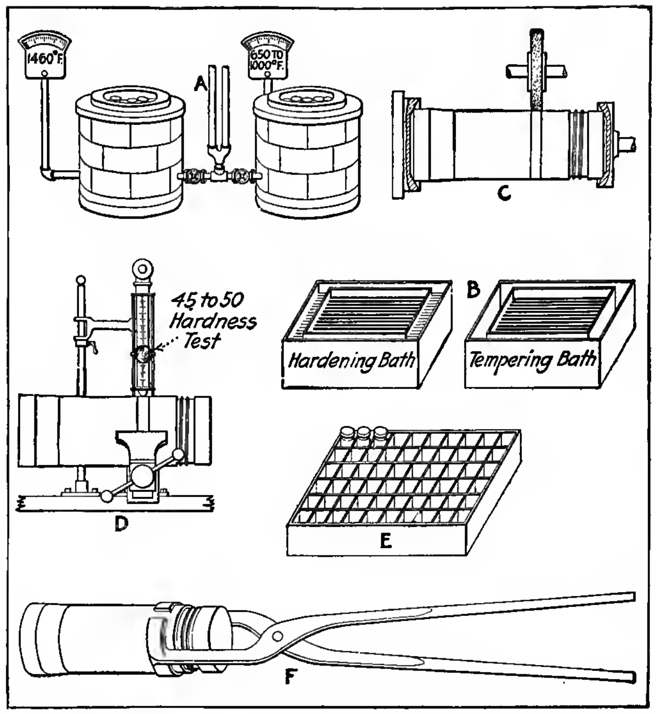
Note—Method of cutting the three-wave cam on engine lathe, shown at K. Waves and recess, shown full size at L.

Reference—See halftone, Fig. 8.

Another well designed device indicates the thickness of the base of the shell. It is shown at *A*, operation 8, and consists of a surface plate, a mandrel for holding the shell and a maximum and minimum gage fastened into a heavy base which slides upon the surface plate.

The transportation system already in use in this plant was well adapted to care for the new line of work. Transfer trucks with removable platforms had been used for some time and it was but a small task to construct special platforms for shells; some of these are indicated in





OPERATION 8. PRELIMINARY SHOP INSPECTION

Gages—For ± thickness of base, A; for ± depth of powder pocket, B; for ± diameter of powder pocket, C; for ± diameter of disk seat, D; for ± length over all, E; for ± diameter of base, F; for ± diameter of recess at bottom, G; for ± diameter over waves, H; for ± recess width, I; for ± distance of recess from base, J; for — undercut, K; for — thickness of nose, L; for — diameter of nose, M. Total, 23 gaging operations.

Production—Fifty shells per hour inspected by two men.

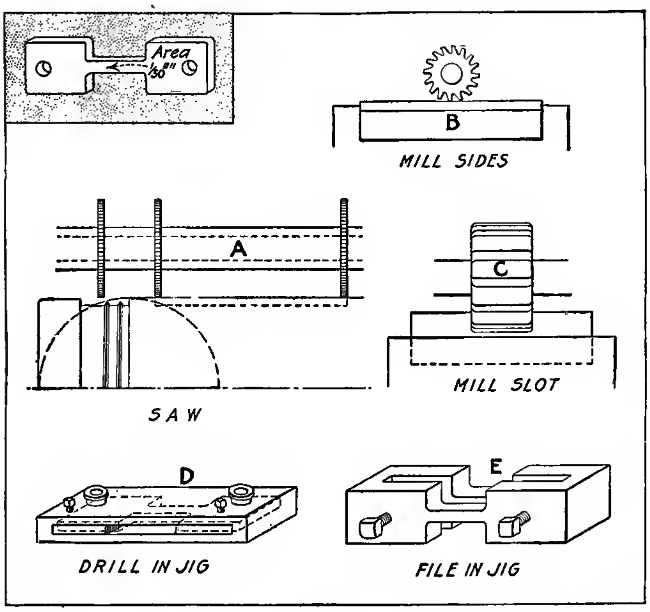
Reference—See halftones, Figs. 9 and 10.

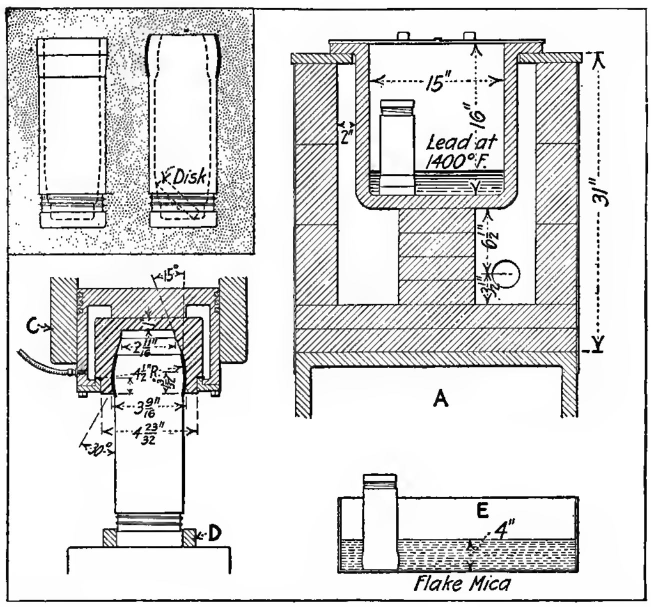
OPERATION 9. HEAT-TREAT, GRIND SPOT AND TEST

Equipment Used—Muffle furnaces for hardening and tempering, A; oil baths for quenching, B; plain grinder for spotting, C; scleroscope, D; boxes for 120 shells, E; special shell tongs, F.

Production—Heating and quenching; 16 shells per hour per furnace. Four furnaces in operation, tended by two men.

Note—Heat treatment consists of heating to 1460 deg. F., and quenching, then reheating to between 650 deg. and 1000 deg. F., according to carbon contents, and tempering. Carbon varies from 45 to 55 points. Oil fuel is used, and heat is controlled by pyrometers. After sorting into batches, two shells are selected at random, one for tensile-strength test, the other for firing proof.





OPERATION 10—MAKE TENSILE-STRENGTH TEST-PIECE

Saw out test-piece on miller, mill flat-faces, mill slot, drill test-piece and file in jig.

Machines Used—Drilling machines and plain miller.

Special Fixtures and Tools—Distance collars for miller arbor for sawing test-piece, A; thickness blocks for miller vise for milling flat faces, B; round-corner cutter for milling slot, C; drill jig for drilling, D; filing jig for filing, E.

Gages—Micrometer.

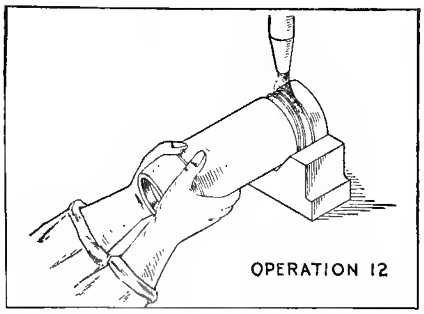
Production—One man performing all operations can produce one in 2½ hr.

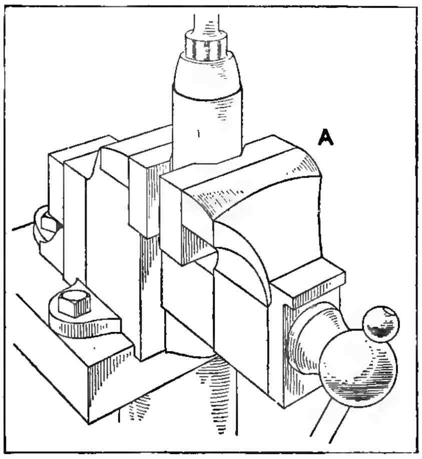
OPERATION 11. REHEAT IN LEAD BATH, INSERT DISK, "BOTTLE" NOSE END, REHEAT AND ANNEAL

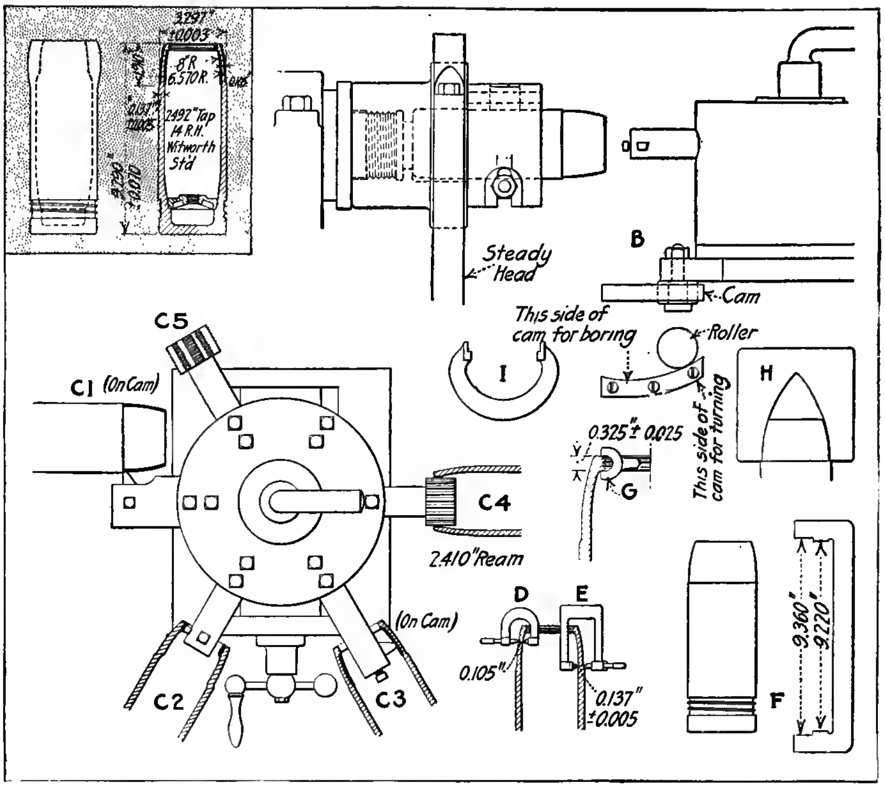
Equipment Used—Lead pot A; bottling press, B; bottling die, C; lower ring, D; mica box, E.

Production—With one lead pot, one bottling press and two men, 60 per hour.

Note—The "disk" is inserted just previous to "bottling," after heating the case. The bottling press used at the Canadian Ingersoll-Rand plant is a rebuilt Leyner mine drill sharpener. The die is water-cooled so the shell will not stick to it.







OPERATION 12. SANDBLAST BASE END AND RECESS

Note—The sandblast has been found most satisfactory to remove the scale due to heat treatment.

Production—One apparatus and one operator, 60 per hour.

OPERATION 14. RETAP NOSE

Machines Used—Radial drilling machines.

Special Fixtures and Tools—Vise for holding shell, A.

Gages—Plug gage for thread.

Production—One operator and one machine, 20 per hour.

Note—For another view of the type of vise used see halftone, Fig. 5.

OPERATION 13. TURN, BORE, FACE AND TAP NOSE END

Machine Used—Turret lathes and engine lathes with improvised turrets.

Special Fixtures and Tools—Hinged and collet chucks, same as operations 4 and 6 (hinged chuck shown at A); nose turning and boring cam, B. Cutting tools: Outside turning and facing tool, C1; boring tool for roughing thread seat in nose, C2; boring tool for boring inside of nose, C3; reamer for thread seat, C4; collapsible tap for tapping thread in nose, C5.

Gages—Gage for wall thickness, D; gage for wall thickness, E; length gage, F; profile template for nose, H; limit snap-gage for large end, I; gage for length of thread seat, G.

Production—From one machine and one operator, between five and six per hour.

Reference—See halftone, Fig. 11.

Fig. 12. Each box holds 60 shells, one-half of the common unit lot-number of 120. The portable vises, shown in Fig. 5, were another convenience which enabled the rearrangement to be made without difficulty. For a number of years fixed work benches have been unknown in this plant. Portable vises with cast-iron stands are used in connection with portable work tables, thus securing great flexibility in the assembling departments. It is also rather peculiar that in a plant arranged for purposes entirely different from shell making, it was unnecessary to change the location of any of the machine tools, and that at the same time the process should be so remarkably free from "back-tracking."

The arrangement of the shop inspections is made with the idea of catching defectives in time to prevent unnecessary labor loss. The first inspection, operation 5, is made to come before the shells are bored, so that any defects or pipes which would condemn the shell may be discovered at this time. Shells which have the least sign of defect at the base end are immediately rejected, since a flaw at this point might be the means of igniting the bursting charge in the shell at the time that the exploding charge in the cartridge case is fired.

Heat treatment is one of the most critical operations on the shell and must be given careful handling. The insistence upon this point is due to the tendency of a shell when fired to change its shape while in the gun. There are enormous strains imposed at this time, and if the material in the shell is of low elastic limit or too ductile, it is likely to expand and grip the bore of the gun, causing an explosion.

The muffle type of furnace has been adopted for heat treating the shells as being more convenient than the ordinary heating furnace, which necessitates a higher lift in placing and removing the shrapnel. It must be stated, however, that the cast-iron pots which are used in the muffles at present are not altogether satisfactory, since they burn out quite frequently. Steps are now being taken to design furnaces of the same general type but constructed entirely of firebrick. Electrical pyrometers are used to indicate and control the temperatures.

The "bottling," or closing-in, of the shell is a simpler operation than most people imagine. The nose end of the shell is heated to a dull red heat in a lead pot. At this temperature, very little force is required to close up the nose end, and it has been done on almost every conceivable kind of a machine from tire upsetters to bulldozers, not excluding steam hammers and punch-presses. At this plant, a reconstructed mine-drill sharpener is used for the purpose, and the bottling die is water-cooled so that the shell will drop out without sticking.

Making 18-lb. British Shrapnel--II

By John H. Van Deventer

SYNOPSIS—The process of finishing the body and nose of shrapnel shells by grinding is described in this issue; also, the comparatively little known operations which follow are shown step by step to complete the shell for shipment. The production time, as well as the means and processes employed, is given for each operation.

Grinding the body and nose of shrapnel shells to finished size is a comparatively recent development in the art of producing these pieces. Especially is this true of grinding the curved face of the nose with a full-width wheel formed to the proper radius. The process is one that has come into use during the last few months, and the Canadian Ingersoll-Rand Co. was the first Canadian shop to employ it. Its experience on this operation is therefore particularly valuable. It is felt that the saving in cost when using a grinder for this purpose, instead of turning the shell to shape in a lathe, is slight, but that the much greater output possible from a given floor space more than offers a compelling inducement.

It is important to keep the wheel in proper shape, especially in view of the fact of the critical inspection to follow. This is done by means of diamond truing-up devices. One of these for the nose wheel is shown in operation 16; it consists of a radial diamond holder mounted so as to reproduce the radius of the shell nose on the grinding wheel. It will be noticed that, in addition to its curve, this wheel has a straight face for approximately ⅜ in. at the side nearest the base end of the shell. This is produced on the wheel after truing the curve by locking the diamond in position and allowing the wheel to traverse. At this point is the "shoulder" of the shell, which is from one to two thousandths larger at this diameter than at any other, excepting, of course, the copper drive band.

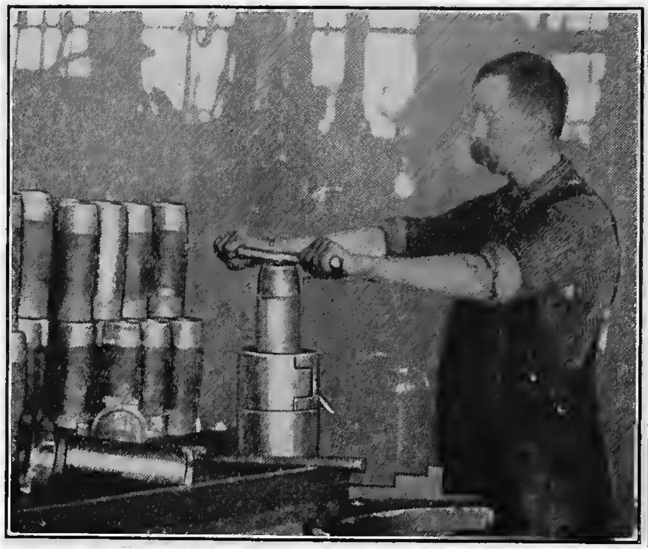


Fig. 14. Fitting Driving Dogs and Center Plugs for Grinding

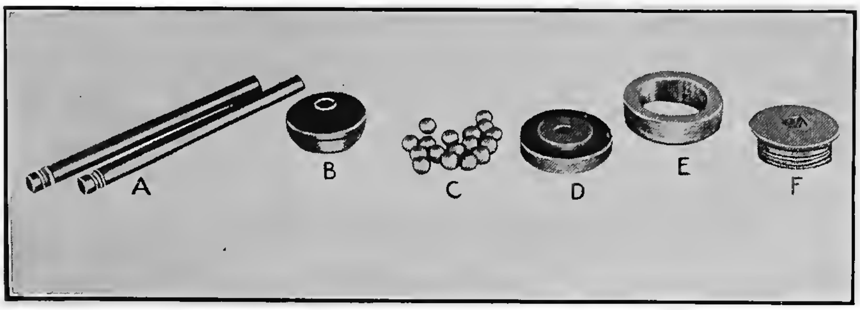


Fig. 13. The Powder Tube, Powder Cup, Lead Balls, Steel Disk, Fuse Socket and Plug

Every effort is made to economize the value of efforts on machine tools. In Fig. 14 is shown a bench with an operator busy fitting the driving dog and plug-center to the shells in preparation for the grinding operations. Thus the grinder operators are enabled to econo-

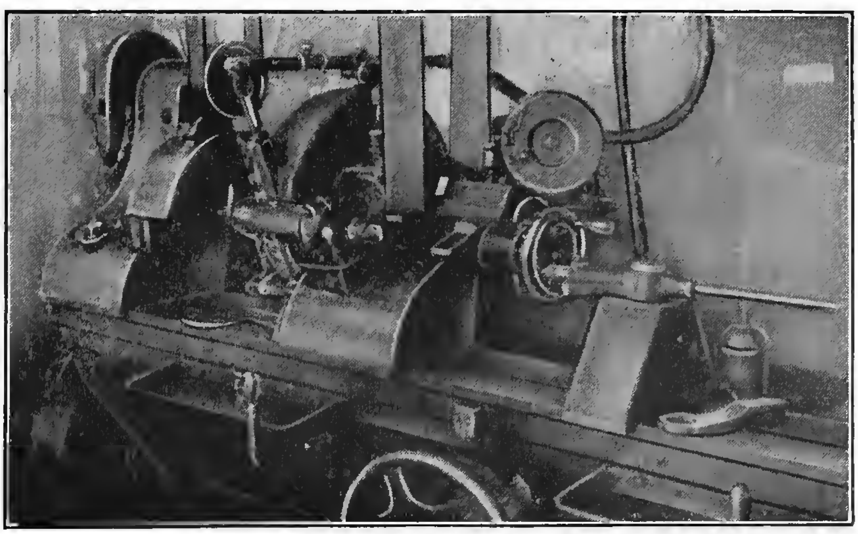


Fig. 15. Grinding the Nose

NOTE—For other articles on tools and methods used in manufacturing war material, published in the columns of the "American Machinist" since the first of the year, see the following: "The Naval Repair Ship 'Vestal,'" page 45; "What a Shrapnel Is and Does," page 89; "Manufacturing Shrapnel Parts on Automatic Machines," page 91; "Machining and Erecting 12-In. Mortar Carriages," page 133; "Some Machine Operations in Making Guns," page 193; "Testing and Special Fixtures for Gun Parts," page 237; "Making Shrapnel Shells with Ordinary Tool Equipment," page 321; "Automatic Production of Shrapnel- and Explosive-Shell Parts," page 397; "The Manufacture of 18-Pounder Shrapnel-Shell Sockets and Plugs," page 439; "A Bridge Shop Transformed into an Arsenal," page 449; "The Double-Spindle Flat-Turret and the 18-Lb. Shrapnel," page 473; "Making the 18-Lb. British Shrapnel—I," page 493.
These articles, including the one beginning on this page, have given to our readers a total of 62 pages of practical information on the manufacture of war material during 1915.—EDITOR.

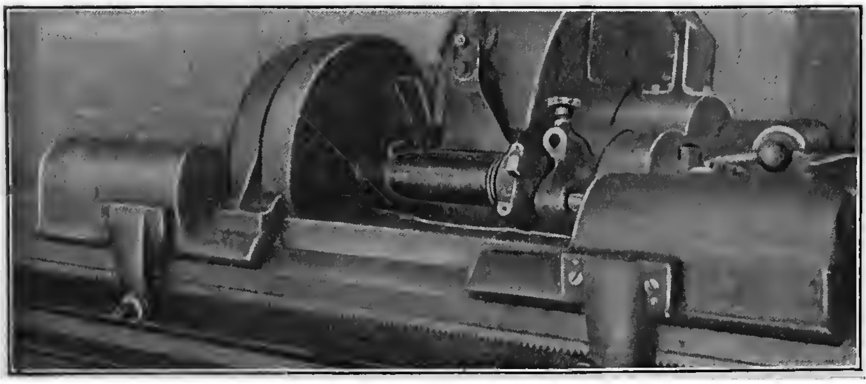


Fig. 16. Grinding the Body of the Shell

mize their time and produce shells at the rate of 20 an hour for the body grinding and 40 an hour for nose grinding. Considerable power is required for these operations, especially for the body grinding. It was found necessary to put up a separate 30-hp. motor for the body-grinding machine, as before the installation of this, the line-shaft speed was considerably slackened due to the power consumption.

Two grinding operations are employed at this plant. This is less than the usual number, one grinding being eliminated by operation 4, in which the base end of the shell was turned to its finished size. Where this is not done, it is necessary to readjust the driving dogs and finish the base of the shell by a third grinding operation.

The Preliminary Inspection

After the grinding processes, the shell is completed as far as its steel case is concerned, all further machining operations being upon the copper and brass attached parts. Therefore, the shells are at this point checked up by the Government inspectors, and to insure as small a percentage of rejections as possible, they are prior to this given what is called a preliminary inspection by the shop inspectors.

One of the most interesting gaging fixtures used is that for determining the thickness of shell walls at various points. This consists of a holder shown in operation 18 at *A* and in Fig. 17 under the corresponding letter. This fixture is made so as to locate the shell accurately with reference to two finished surfaces that serve as bases for special micrometers to rest upon, insuring that the thickness of wall shall be gaged in each case at similar points.

The micrometers, if such they may be called, are also unusual. The measurement is not made by means of a screw, but by plus and minus location surfaces on the sliding spindle, which indicate by their alignment with a milled recess in the holding sleeve. The register of these plus and minus surfaces can be felt with the finger nail without the necessity of looking at the gage.

The Government inspectors have been forced instinctively to adopt a sort of motion study in order to keep up with their work. With over 40 inspections on each shell and 500 shells per day, it requires a great deal of activity on the part of six men to keep up the 20,000 necessary measurements. As a result, the operation has become very specialized. The inspectors follow one another, some of them with gages in each hand, along the lines of shells laid out on benches. It is a question as to how much these methods which have resulted from having to get the job done in a given time could be improved by actual time or motion study made in advance of the work.

The Copper Drive Band

The copper drive band is a very important part of the shell. It is forced

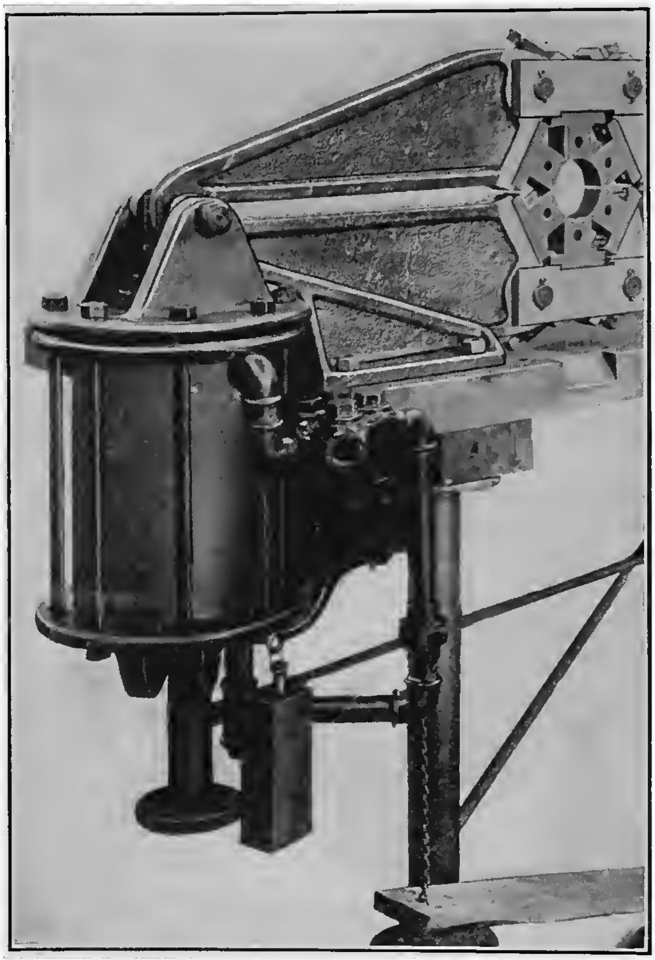


Fig. 18. The Drive-Band Hydraulic Crimping Press

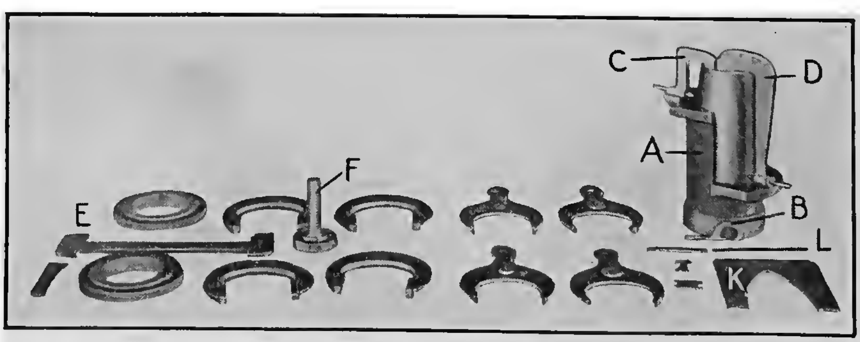


Fig. 17. Gages Used in the Second Inspection

into the rifled grooves of the field piece, and causes the shell to rotate as it travels through the air. This copper band in reality imports the spin to the entire shell and does this in such a short interval that the strain to which it is subject is enormous. There must be no possibility of its turning on the shell. This is the reason for the peculiarly waved ribs in the band recess.

Fig. 19. The Shot Box

The drive bands in the rough shape are simply copper rings large enough to go over the base end of the shell. One or two blows of a hammer secures them from falling off until they are forced down into the recess by the band-crimping press. The machine used for this purpose at the Ingersoll-Rand plant is one of their own design and is shown in Fig. 18. The crimping dies are actuated by toggles connected with a lever arm that is operated by a compressed-air piston. This type of banding press appears to be more convenient than the horizontal type, in which the weight of a shell must be supported at arm's length.

It would hardly be believed that the amount of air contained between the two waved ribs and the copper band would prevent the latter from being properly seated. Those, however, who have not had any experience with

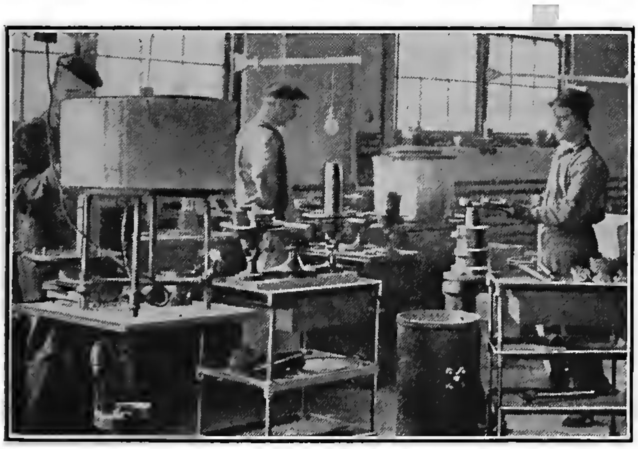


Fig. 20. Filling the Shells with Rosin, and Screwing in the Plugs

the manufacture of shells are quite likely to spend time and possibly profanity at this point until they simplify matters by chipping an air-release groove through the ribs.

The drive band is machined to a very peculiar finished shape. This is shown in operation 21, which also indicates the process by which the copper band is turned to its final form. The lathe on which this operation was observed had a "home-made" forming slide attached to the rear of the carriage. This slide carried a tool which took the finishing cut. Being fed tangentially across the work instead of straight in toward the center, this tool took a shearing cut and distributed the heat much more than a radially fed forming tool would do. In fact, before this attachment was used, front and back radial forming tools were employed, and the shell became so hot that to prevent distortion it was necessary to fill it with soda water previous to this operation.

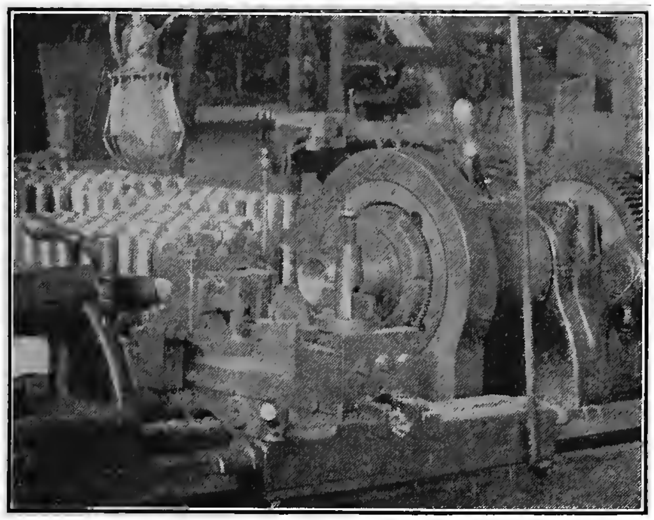


Fig. 22. Finishing the Fuse Socket

It would be difficult to give the reason for such a peculiar outline as is required in the 18-lb. shell drive band. What would render an explanation more difficult, is the fact that the 15-pounder, which is but $\frac{3}{10}$ in. less in diameter, has a comparatively plain drive band without any reverse curves, which is much simpler in every way to machine and measure.

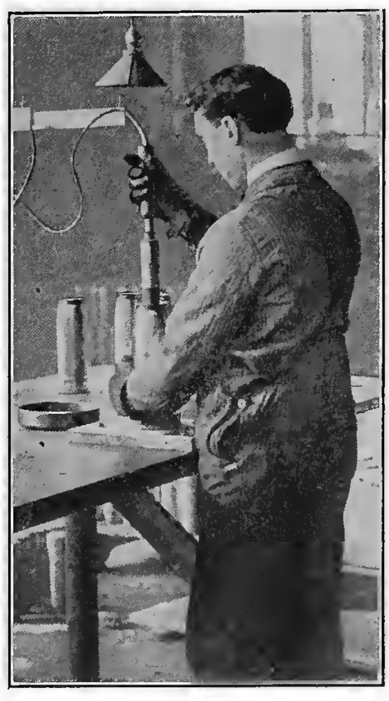


Fig. 21. Soldering the Powder Tube to the Fuse Socket

Filling the Shell

An understanding of the succeeding few operations in which the shells are filled will be helped by referring to Fig. 13. Here are shown the parts to which reference will be made frequently. The brass powder tube having a shoulder at one end and a thread cut beneath it is shown at *A*. At *B* is the tin powder cup of a shape to fit in the powder pocket, and at *C* the ½-in. lead balls which are used in this size of shell. At *D* is the steel drive disk, which is an unfinished drop forging, and at *E* the brass fuse socket, which is machined from a brass stamping. At *F* is the brass plug, which is made from a casting. All of these parts, as well as the steel shell forgings are furnished to the plants that are turning out shrapnel.

The parts *A, B, C, D* and *F* are in finished shape when received and require no labor other than that of assembling them into the shell. The fuse socket *E,* however, after becoming a part of the shell, is machined as shown in operation 27. The Canadian shell manufacturers who perform the operations described in this article furnish only their labor.

It is somewhat of a problem to the uninitiated to figure out how the tin powder cup, which goes into the powder pocket underneath the steel disk, can be introduced af-

FIG. 23. REAMING THE POWDER TUBES

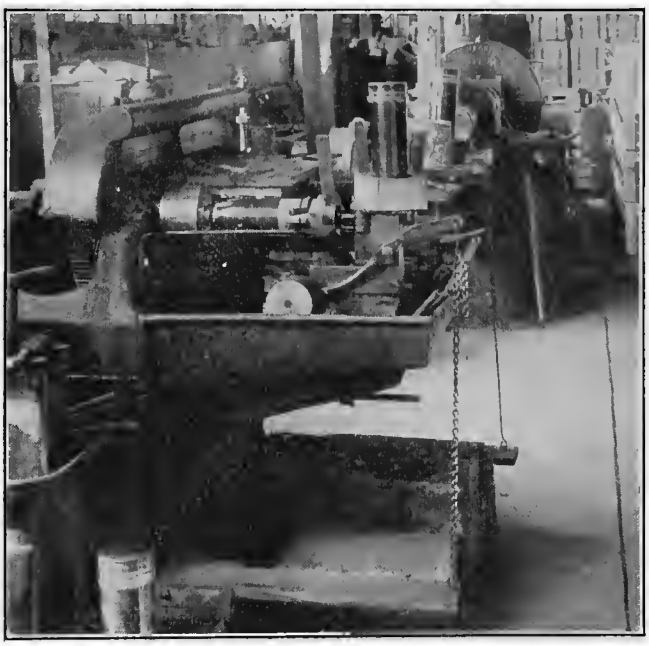


FIG. 24. IMPROVISED PAINTING MACHINES

ter this disk is within the shell. The man who is doing this work does not seem to find it difficult. Proportions and dimensions are so figured that a dexterous movement causes the steel disk to turn a somersault, carrying the tin powder cup with it to its correct position. The powder cup is, of course, empty. Later on, but not at this plant, it is to be filled with the explosive charge which will cause the shell to burst. The brass powder tube makes this possible by keeping a source of communication open between the fuse socket and the tin powder cup.

LEAD BALLS EMBEDDED IN ROSIN

The Government is particular to have each shell inscribed with the date of manufacture and the initials of the plant in which it was made. This is done upon the side or body of the shell, and for this purpose the Ingersoll-Rand Co. has pressed into use the inscription-rolling machine with which they formerly marked the barrels of their pneumatic hammers. That it is well adapted for this purpose is indicated by the fact that the man who operates it is also able to take care of inserting the tin powder cups and of screwing the brass powder tubes into the

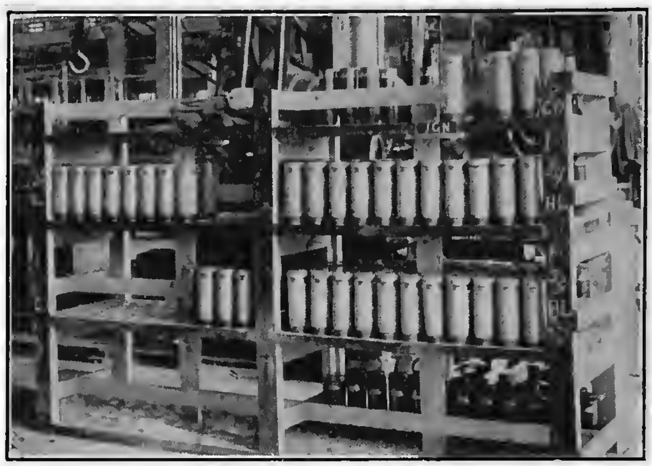


FIG. 25. DRYING RACKS FOR PAINTED SHELLS

FIG. 26. THE SHIPPING BOXES

disks after the latter have been driven home with blows of a hammer.

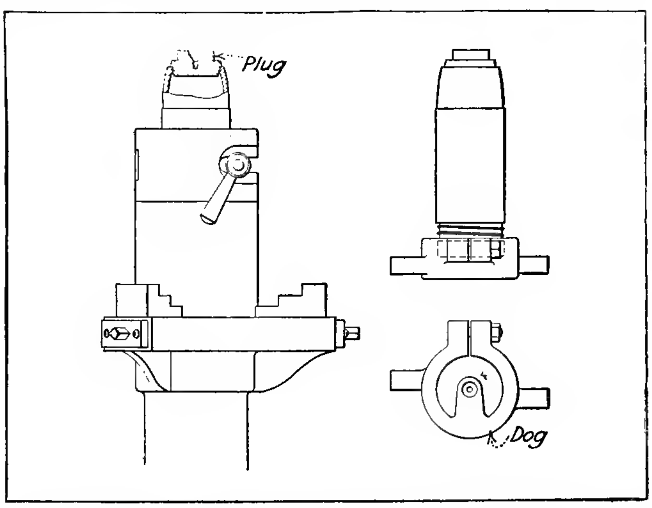
One who might anticipate difficulty in getting a full measure of peas or potatoes on account of their not settling to the bottom of the receptacle, would not expect to encounter similar trouble in connection with shot. But it exists, and for that reason it is necessary to do one of two things to get the required number of balls in a shrapnel shell—either put them in under pressure or jar them down by vibration. The latter plan has been adopted as cheaper, and a molding machine vibrator has been "borrowed" for this purpose and attached to a small round table upon which the shells are placed while being filled from the shot box. The funnel which is used to introduce the shot has a central boss with a hole in it that serves the purpose of centering the free end of the brass powder tube. The man who fills the shells with shot must also give them a preliminary weighing to be sure that he has introduced a sufficient number.

FIG. 27. A 350-LB. CANADIAN, AND 2 BRITISH 18 POUNDERS

ONE REASON FOR THE ROSIN

If one tries to imagine the action of a rapidly rotating hollow shell filled with round balls of such a heavy material as lead, one can see a very good reason for cementing the shell and its contents into one solid mass by means of rosin. If they were not held homogeneously by some such material as this, the shell would perform very peculiar actions during its flight very similar to those of a "loaded" ball on a bowling alley. Another reason for filling up the air spaces between the balls is that it gives the explosive charge less room to expand and therefore bursts the shell with greater force.

The men who fill the shells with rosin also take care of the final weighing. They are allowed to make up the weight of one $\frac{1}{2}$-in. ball by means of bucketshot; this giving them a slight margin whereby they can correct

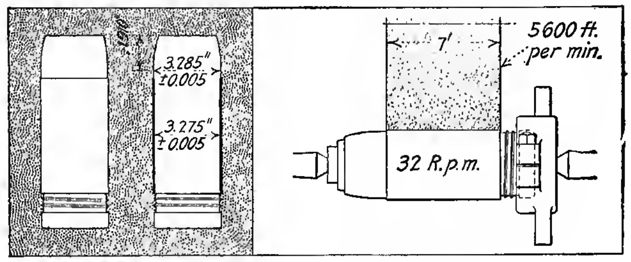


OPERATION 15. FIT DOG AND PLUG-CENTER FOR GRINDERS—REMOVE DOG AND PLUG-CENTER

Equipment Used—Hinged chuck used as vise.
Production—Two men, 60 per hour.
Reference—See halftone, Fig. 14.

variations in the weight of the metal parts. This weighing must be done in a hurry, for the shell must be handed to another operator who screws home the fuse socket before the rosin sets.

Extreme uniformity of weight is very necessary in these shells. The fuse, which will be added before the shells are fired, is graduated in $\frac{1}{6}$-sec. divisions, each of which corresponds to approximately 50 yd., becoming less, of course, as the shell nears the end of its flight. Therefore, to make range-finding possible, the action of shells of the same caliber must be very similar. A slight difference



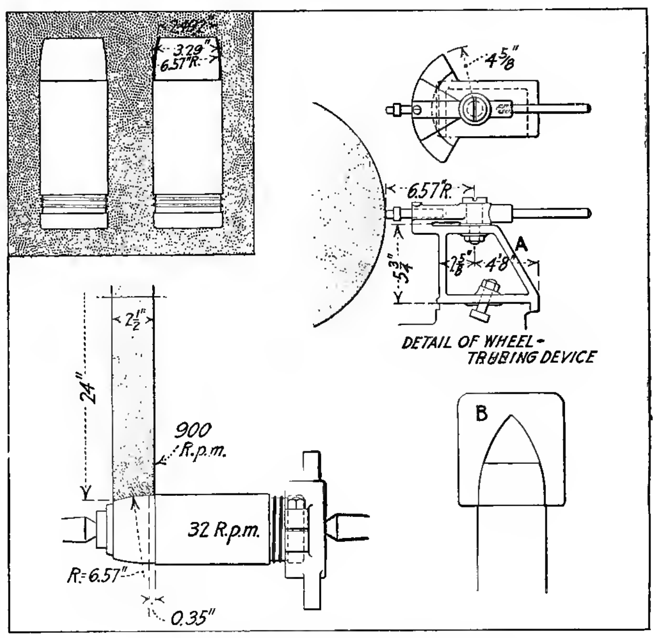
OPERATION 17. GRIND BODY

Machines Used—Norton and Landis plain grinders.
Special Fixtures and Tools—Driving dog and plug-center (see operation 15).
Gage—Micrometer.
Production—One operator and one machine, 20 per hour.
Note—Wheel and work speed, and composition of wheel, same as in operation 16. Wheel maintenance averages 1c. per shell. Power required averages 30 hp.
Reference—See halftone, Fig. 16.

of weight would be fatal to accuracy. The total allowance is plus or minus $4\frac{1}{2}$ drams, making a total tolerance of a little over $\frac{1}{2}$ oz. on a weight of 18 pounds.

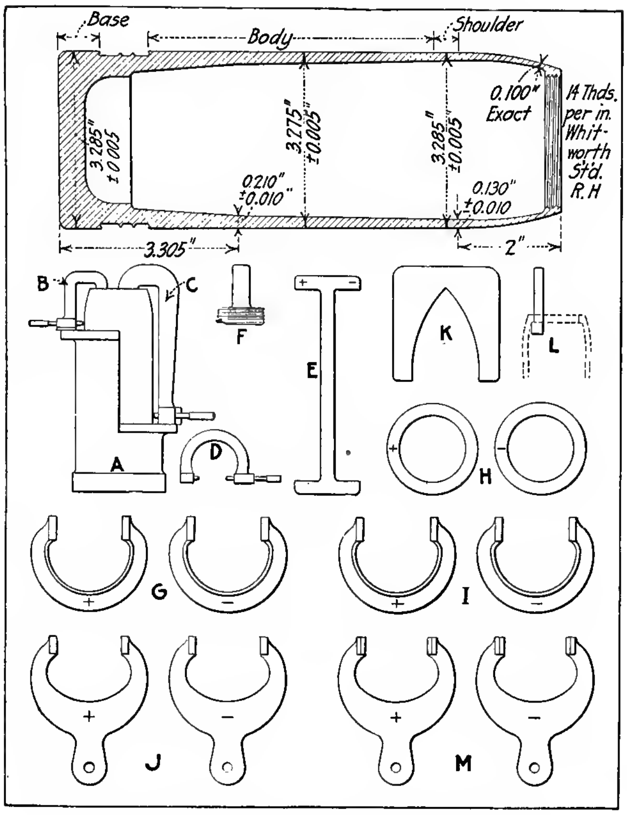
SOLDERING 60 TUBES AN HOUR

One of the busiest men in the plant may be seen in Fig. 21. He is soldering the powder tubes as described in operation 26. The tubes must be soldered fast to the fuse sockets, and he does this by placing the shells one at a



OPERATION 16. GRIND NOSE

Machines Used—Norton and Landis plain grinders.
Special Fixtures and Tools—Wheel-truing device, A; driving dog and center-plug (see operation 15).
Gages—Profile gage for nose, B; micrometer for large diameter.
Production—One operator and one machine, 40 per hour.
Note—Grinding wheel used is crystolon, grade L, in a grain mixture of $\frac{1}{3}$ each 24-36 and 46. The output per wheel varies between 3200 to 9800 shells. The frequency of wheel dressing is once per 10 to 30 shells, with a maximum of 1 in 3 and a minimum of 1 in 78 shells.
Reference—See halftone, Fig. 15.



OPERATION 18. SHOP INSPECTION

Special Fixture—Holder for shell for gaging wall thickness, A.

Gages—Micrometer for wall thickness, B; for wall thickness, C; for wall thickness, D; for ± overall length, E; for thread in nose; for ± diameter of base, G; for ± diameter at shoulder, H; for ± body diameter, I; for ± diameter over waves, J; for nose profile, K; for depth of nose recess, L; for ± diameter of bottom of wave recess, M. Total of 17 gaging operations.

Production—Sixty shells per hour for two men.

Reference—See halftone, Fig. 17.

OPERATION 19. FIRST GOVERNMENT INSPECTION

(Not illustrated)

Gages—Similar to those shown in operations 8 and 18.

Production—Six government inspectors take care of both the first and final inspection of 600 shells per day.

time upon the rotating ball-bearing table, placing a solder ring over the outside of the tube where it projects through the fuse socket, and then completing the operation by holding the point of an electric soldering iron within the tube and spinning it around by hand until the solder melts. Such simple helps as the ball-bearing table and the solder rings make this remarkable production time a possibility.

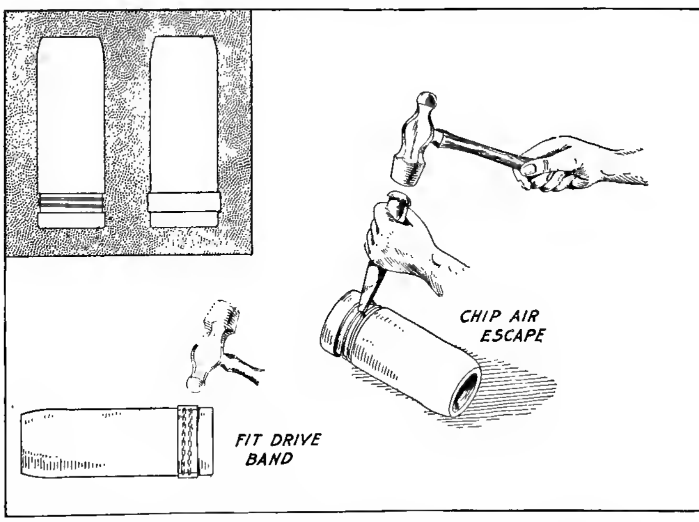
The last machine operation, shown in diagram in operation 27, is to finish the protruding part of the fuse socket and to face the powder tube and surplus solder. Sometimes is is necessary to clean out and ream the powder tubes with an air drill and reamer, as shown in Fig. 23; if not, the shells go direct to a final inspection after the brass plug has been inserted in the fuse socket and fastened with a grub screw.

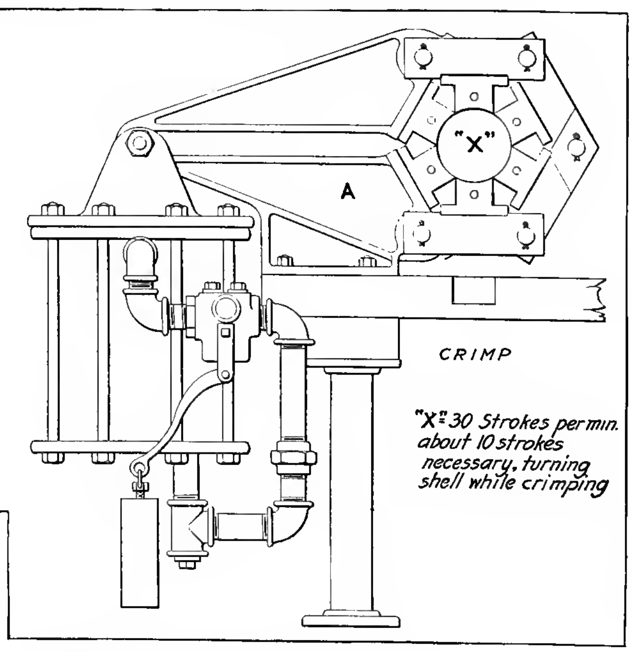
Painting with Bolt Thread-Cutting Machines

To facilitate painting by means of bolt thread-cutting machines, seems like a far-fetched step; nevertheless the modified bolt cutters which rotate the shells between spring cup centers assist materially in getting out the large daily product at small labor cost. One of these machines is used for priming the shells, and the other, for applying the finishing coat. Both of them are shown in Fig. 24.

The shipping boxes which are used to inclose the shells in their journey across the water are shown in Fig. 26. It will be noted that there is nothing cheap about them, 26 wood screws and two spliced ropes being used on each one, to say nothing of the iron braces. When one considers that two modern field pieces without really over-exerting themselves, can use up shells as fast as they can be produced in a factory of the size described, one begins to get a slight appreciation of the amount of money that is at present going up in smoke. And such consideration lends emphasis to the statement recently credited to a British commander, that the present need is "ammunition, more ammunition, and yet more ammunition."

The tremendous mental and physical efforts put forth to furnish this enormous supply can be dimly realized when we think that this long article has described the methods of only one shop out of 130 in only one colonial possession of one of the seven warring nations.





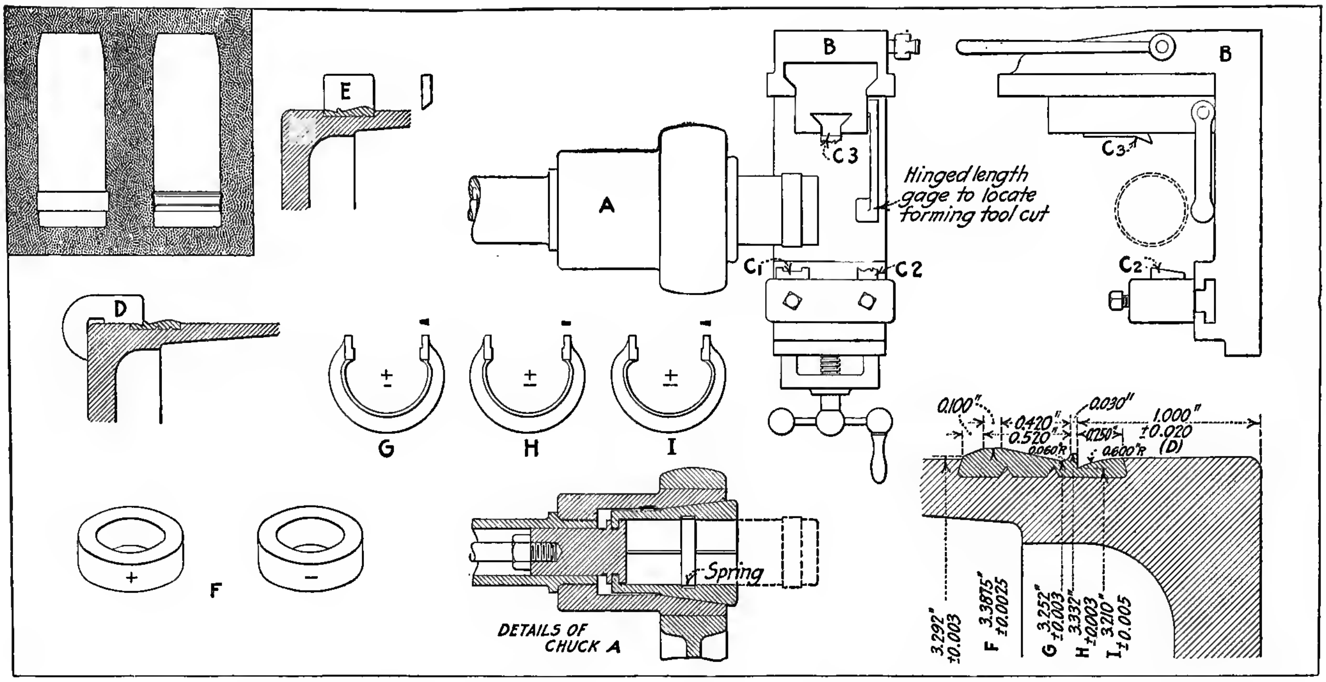
OPERATION 20. CUT NOTCH TO PERMIT AIR TO ESCAPE BETWEEN WAVES, FIT COPPER DRIVING BAND AND CRIMP BAND IN BAND-CRIMPING PRESS

Equipment Used—Special pneumatic crimping press, A.

Production—One machine and two operators (double shift), 30 shells per hour.

Notes—This press was designed and constructed at the Canadian Ingersoll-Rand shops. The copper drive bands must be annealed dead soft.

Reference—See halftone, Fig. 18.



OPERATION 21. TURN AND FORM DRIVE BAND

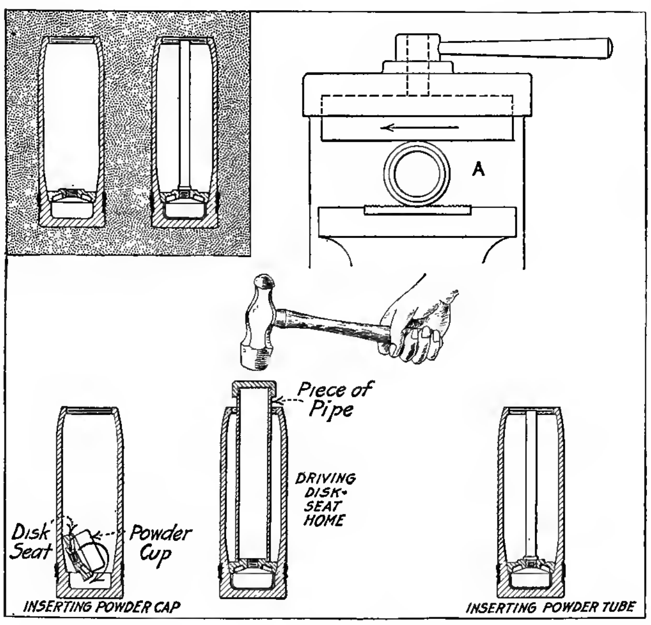
Machines Used—Brass lathes and engine lathes with special forming slides.

Special Fixtures and Tools—Draw-in collet-chuck, A, and special forming slide, B. Cutting tools: Width tool, C1; rough turning tool, C2; finish forming tool, C3.

Gages—For height of radius from base, D; for form of band, E; for ± diameter at F, F; for ± diameter at G, G; for ± diameter at H, H; for ± diameter at I, I.

Production—From one machine and one operator, 15 per hour.

Note—Previous to using the rear forming slide for finishing, the shell became so hot that it was necessary to fill it with soda water and plug the end before this operation.



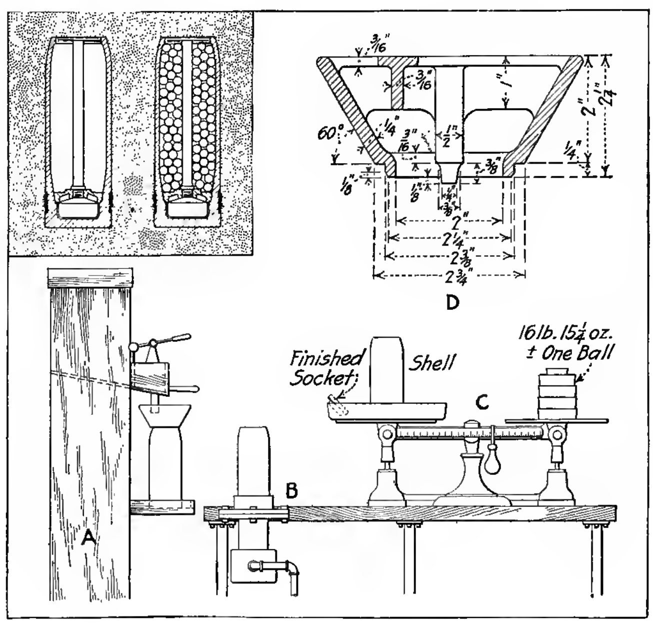
OPERATION 22. STAMP SHELL WITH INSCRIPTION, INSERT TIN POWDER CUP, DRIVE DISK HOME, AND INSERT BRASS POWDER TUBE

Equipment Used—Rolling press for inscription, A.

Production—One man, 40 per hour.

Note—Tin powder cup shown at B in halftone, Fig. 13; brass powder tube shown at A in halftone, Fig. 13; steel disk shown at D in halftone, Fig. 13.

Note also the method of nesting the powder cup and disk seat when they are inserted.



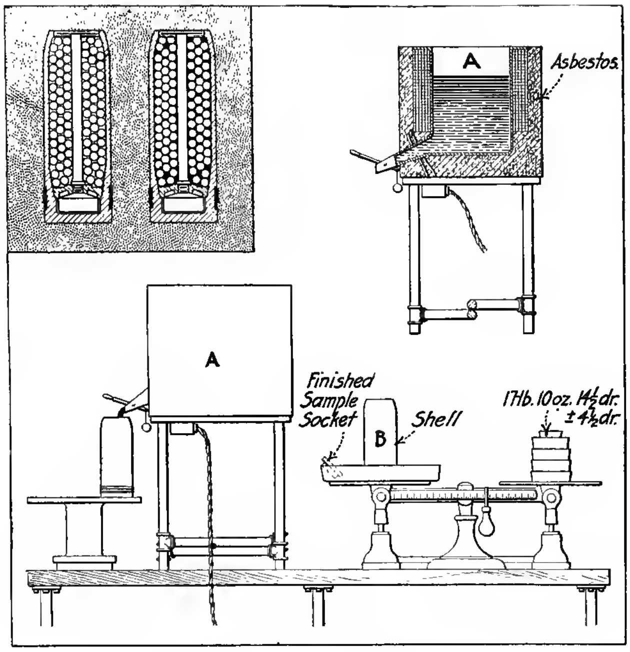
OPERATION 23. FILL WITH BALLS, JAR DOWN ON VIBRATOR AND WEIGH

Equipment Used—Shot box with self-measuring hopper, A; vibrator table, B; scales, C; shot funnel for centering powder tube, D.

Production—One man, 50 per hour.

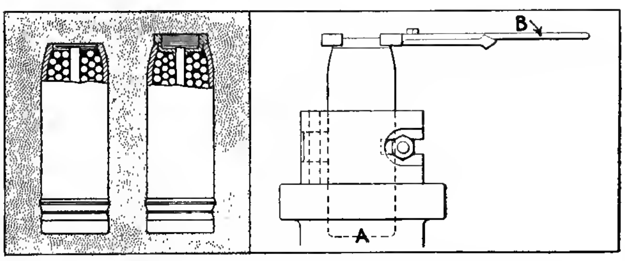
Note—The necessity for shaking down on the vibrator depends on the roughness of the shot used. The vibrator is "borrowed" from a molding machine.

Reference—See halftone, Fig. 20. Shot shown at C in halftone. Fig. 13.



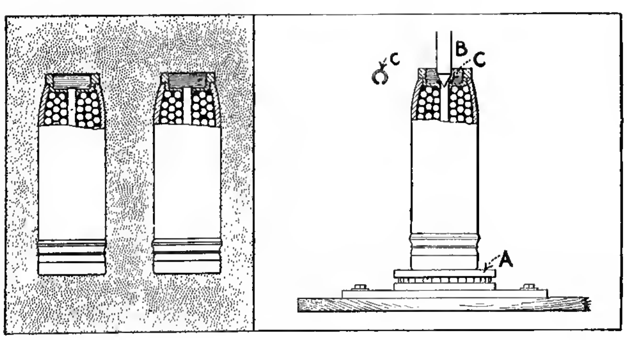
OPERATION 24. FILL WITH ROSIN AND WEIGH

Equipment Used—Electric rosin pot, A; scales, B.
Production—Two men and two rosin pots, 60 shells per hour.
Note—The rosin must be heated between 360 deg. to 400 deg., to fill the shell properly. The curent consumption of each pot is 2½ kw., 11 oz. 10½ drams of rosin are required per shell. Exact weight is made with buckshot.
Reference—See halftone, Fig. 20.



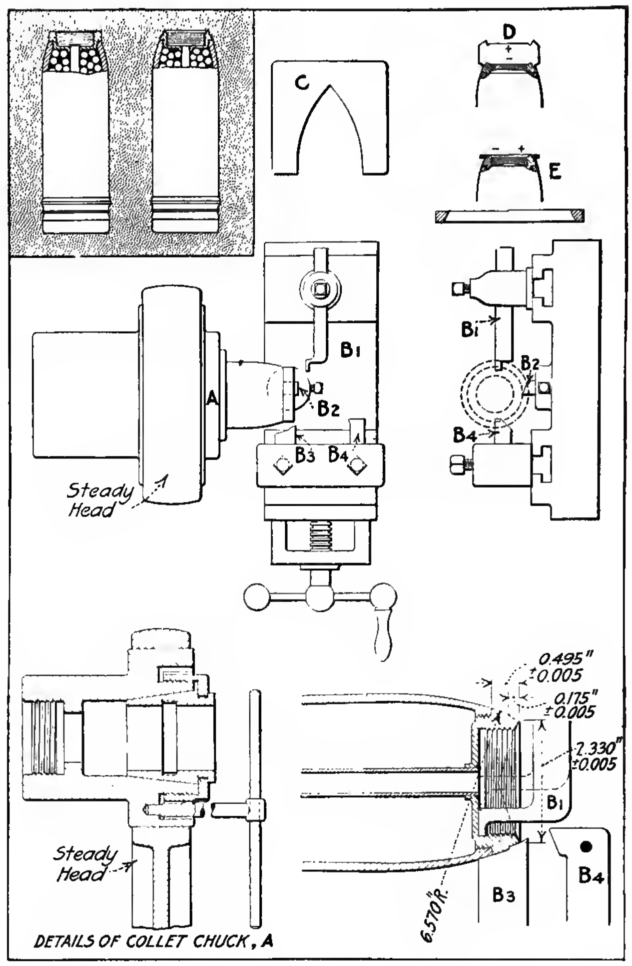
OPERATION 25. SCREW IN FUSE SOCKET

Equipment Used—Special hinged chuck, as vise, A; special tongs used as a wrench, B.
Production—One man, 60 per hour.
Reference—See halftone, Fig. 20. Fuse socket shown at E in halftone, Fig. 13.



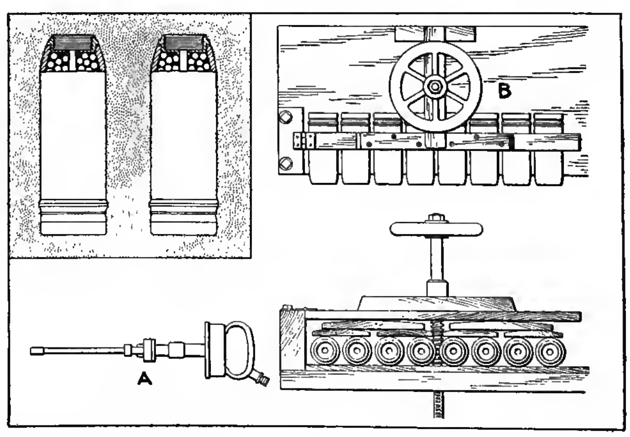
OPERATION 26. SOLDER POWDER TUBE INTO FUSE SOCKET

Equipment Used—Special ball-bearing table for rotating shell, A; electric soldering iron, B; solder rings, C.
Production—One man, 50 to 60 shells per hour.
Note—This remarkably high production rate has been maintained for several months.
Reference—See halftone, Fig. 21.



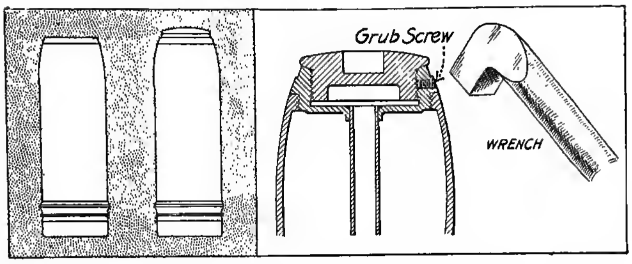
OPERATION 27. TURN, FACE AND UNDERCUT FUSE SOCKET, FACE CENTRAL POWDER TUBE

Machines Used—Brass turrets and modified engine lathes.
Special Fixtures and Tools—Special split collet chuck with scroll ring, A. Cutting tools: Facing and recessing tool, B1; rough turning tool, B2; forming tool, B3; forming tool, B4.
Gages—Profile template, C; limit bevel gage, D; nose undercut limit gage, E.
Production—One man and one machine, 10 per hour.
Reference—See halftone, Fig. 22.



OPERATION 28. CLEAN OUT AND REAM POWDER TUBE (IF NECESSARY) AND INSPECT

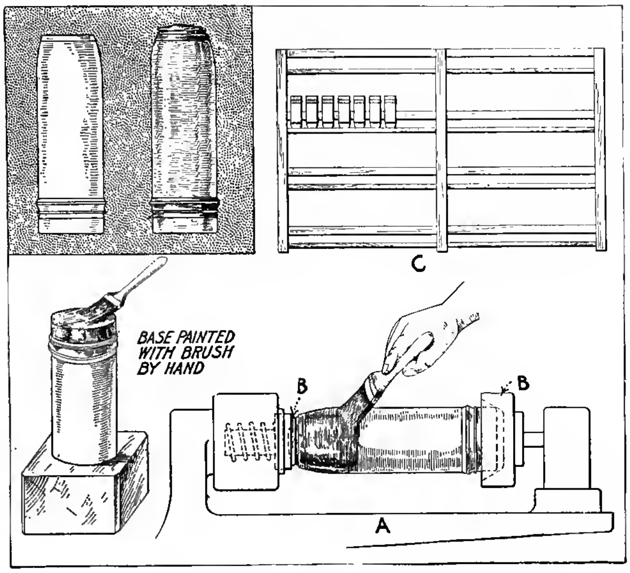
Equipment Used—Air drills driving reamers, A; special equalizing clamp, B.
Gages—Fuse socket gages as described for operation 27. Drive band gages as described for operation 21.
Production—Twenty per hour per man.
Reference—See halftone, Fig. 23.



OPERATION 29. INSERT FUSE-HOLD PLUG AND GRUB-SCREW

Equipment Used—Special vise, similar to those shown in operation 25.
Production—One man, 50 per hour.
Note—The fuse-hole plug is a brass protecting plug and is removed when the fuse itself is attached.
Reference—See halftone, Fig. 20.

OPERATION 30. FINAL GOVERNMENT INSPECTION
(Not illustrated.)



OPERATION 31. PRIME AND PAINT

Equipment Used—Reconstructed bolt threaders, A; spring cup centers, B; drying racks, C.
Production—Four men; prime, paint and stack 60 shells per hour.
Note—Shells are left to dry 24 hr. between primer and finish coat. Steel work is finished in naval gray, copper parts are finshed with red lead.
Reference—For painting machines, see halftone, Fig. 24. For drying racks, see halftone, Fig. 25.

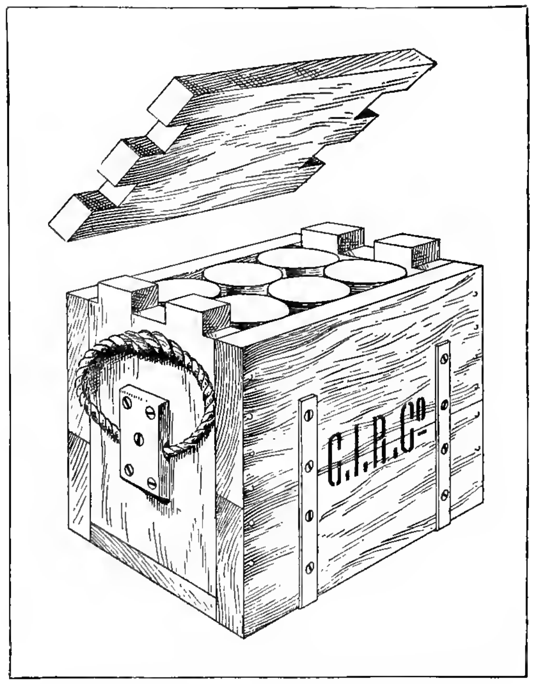
No Discrimination

An opinion has been expressed in Germany that American machine-tool builders are, as a whole, in sympathy with the Allies and that, as a result, England, France and Russia are well supplied with American machinery, while Germany is forced to go without it.

There is a half-truth here which has led to this belief. Very few machine tools are finding their way from this country into Germany. But this is not the fault of the American machine-tool builders, of whom probably one-third are of German descent.

The reason for this apparent discrimination, which may seem like a breach of neutrality, can be inferred from the answer given us by the commercial department of the German Consulate at New York when we inquired how American manufacturers could ship their products to Germany.

"We are sorry, but we are not able to tell you. Shipping direct is at present out of the question. It is possible that small numbers of machine tools are finding their way into Germany through neutral nations."



OPERATION 32. BOX FOR SHIPMENT

Note—Six shells are placed in each box.
Reference—See halftone, Fig. 26.

When our informants in their position of knowledge cannot state how machinery may be shipped to their country, it is hardly fair to expect the American manufacturer to solve the problem. The reëxportation of these goods from neutral countries is a very difficult thing at present, and is reflected in the requirements of steamship companies that act as carriers to the neutral countries bordering Germany or Austria.

The Italian lines, before Italy's entrance into the war, refused to accept any shipments of machinery except such as were accompanied by a sworn statement naming the consignee, who must be an Italian. The reëxportation of this class of material is not recognized. The Holland-American Line accepts shipments of machine tools and other machinery for reëxportation only after a sworn manifest has been forwarded to Rotterdam and has been viséed by the British Consul General. The goods are held in this country in the meantime awaiting cable advise that shipment is permitted. The Scandinavian-American Line will accept no assignment of machinery for reëxportation from their country, and shipments to Scandinavia must be accompanied by certificates identifying the consignee. The Norwegian-American Line accepts machinery consigned to a definite consignee and does not require a declaration, but it does not accept goods for reëxportation to Germany.

On the other hand, it is easy for American shippers to forward goods to Great Britain, France, or Russia. The English lines accept shipments of all kinds—contraband, conditional and otherwise—for delivery to points within Great Britain without any unusual formalities on the part of the shipper. Goods which are carried by English steamship lines for reëxportation to neutral countries must be accompanied by sworn certificates showing their destination and use. Naturally, they do not carry freight for Germany.

The Double-Spindle Flat-Turret and the 18-lb. Shrapnel

Editorial Correspondence

SYNOPSIS—This article describes the process of machining shrapnel cases on a double-spindle flat-turret lathe as practiced in the western part of Ontario, Canada. One of the features of the tool set-up as observed in this shop is a combination internal-and-external chuck which assures plenty of driving power.

One of the peculiar things about modern warfare is the number of men that are required to keep one field piece of even moderate size in operation. It takes not only a man behind the gun but it requires an almost unbelieveable number of men behind each gunner to keep him supplied with ammunition. Therefore, one finds almost every conceivable type of machine tool from automatic machines to bolt cutters pressed into service to meet the constant demand for projectiles. Even millers are being used for boring and turning the 15- and 18-lb. British shells, although they are among the last machines that one would imagine adaptable for this purpose.

In another article in this reprint will be found a description of the Jones & Lamson single-spindle flat-turret lathe engaged in turning out shells. Those manufacturers in Canada who had flat turrets of the double-spindle type already installed in their plants lost no time in fitting them up with the necessary tool equipment required for shrapnel-case work.

In the plant where the machine mentioned was observed, it had been fitted with a chuck of novel design. Ordinarily, for the first operation, the shells are gripped on the inside by means of an expanding arbor. In this case, almost unlimited additional driving power was secured by the use of a three-jaw exterior-gripping chuck. Since the thickness of the shell varies in the rough forging, it was necessary to make provision so that the alignment of the work should be determined by the inside chucking and gripped by the exterior chuck jaws simply in conformity to this. This was accomplished by cutting away the scroll support of the chuck so that in reality it forms a floating scroll ring, permitting the jaws to accommodate themselves to the work as chucked on the internal arbor but retaining the function of closing together when the scroll is turned. Fig. 1 shows this chuck.

The sequence of operations on the two-spindle machine is quite similar to that described for the single-spindle. The following is a schedule of these operations:

First Operation: 1. Rough-turn the outside diameter of shell body. 2. Form the recess and shape the base end of the shell. 3. Form the waves. 4. Undercut the recess for the drive band.

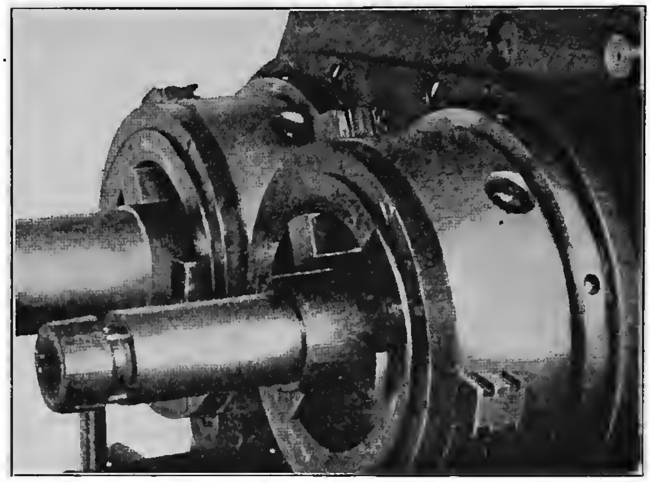


Fig. 1. The Double Gripping Chuck

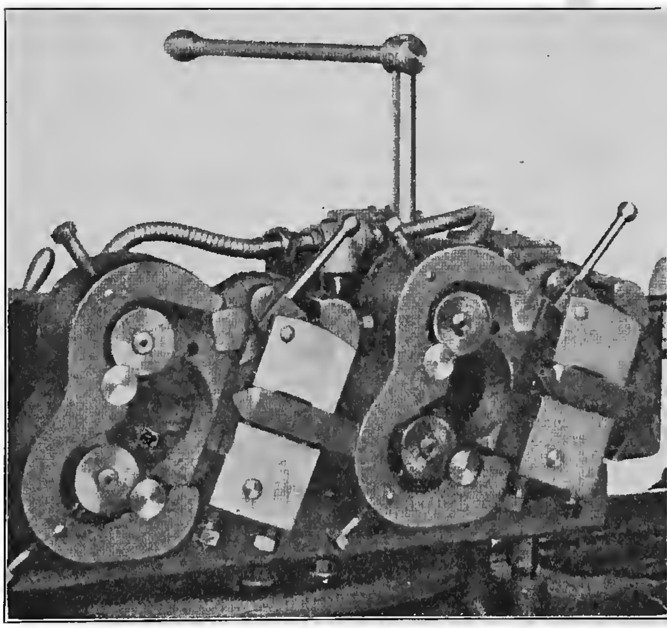


Fig. 3. Tools for Rough-Turning the Shell

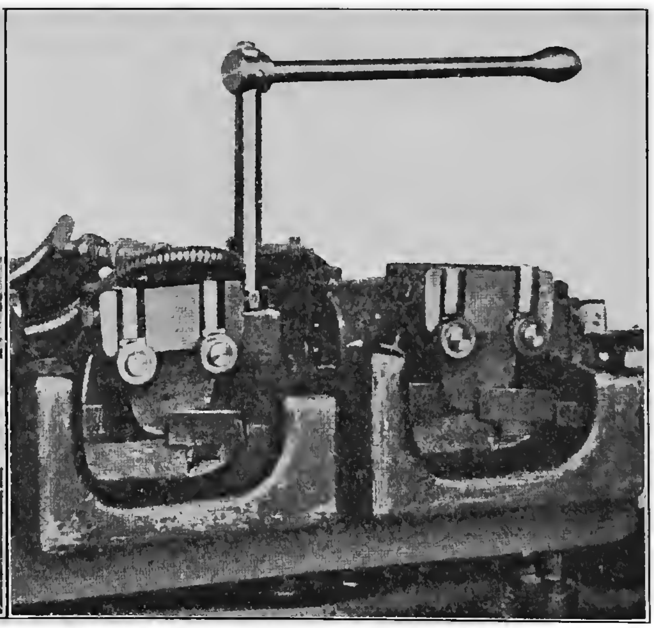


Fig. 4. The Forming and Facing Tools

Second Operation: 1. Rough-bore the powder pocket and turn the nose-end taper for bottling. 2. Rough-bore the disk seat. 3. Finish-bore the powder pocket. 4. Finish-bore the disk seat.

Third Operation: 1. Bore the nose for its tap hole and rough-turn the nose profile. 2. Face the end and rough-form the inside of the nose. 3. Finish-face the end and finish-form the inside of the nose. 4. Tap with a collapsible tap.

It must be remembered that these operations do not occur in sequence upon the shell, there being a gap between the second and third operations during which the shell is heat-treated, the disk is inserted and the nose end is bottled.

The double-spindle flat-turret operations are shown in diagram in Fig. 2, which also represent the tool set-up as observed in this plant. An interesting feature of the third operation is the attempt to finish the inside of the nose by means of circular forming tools. While this method looks very promising, it has been in use for such a short time at this writing, that it is impossible to say whether or not it will be entirely successful. The

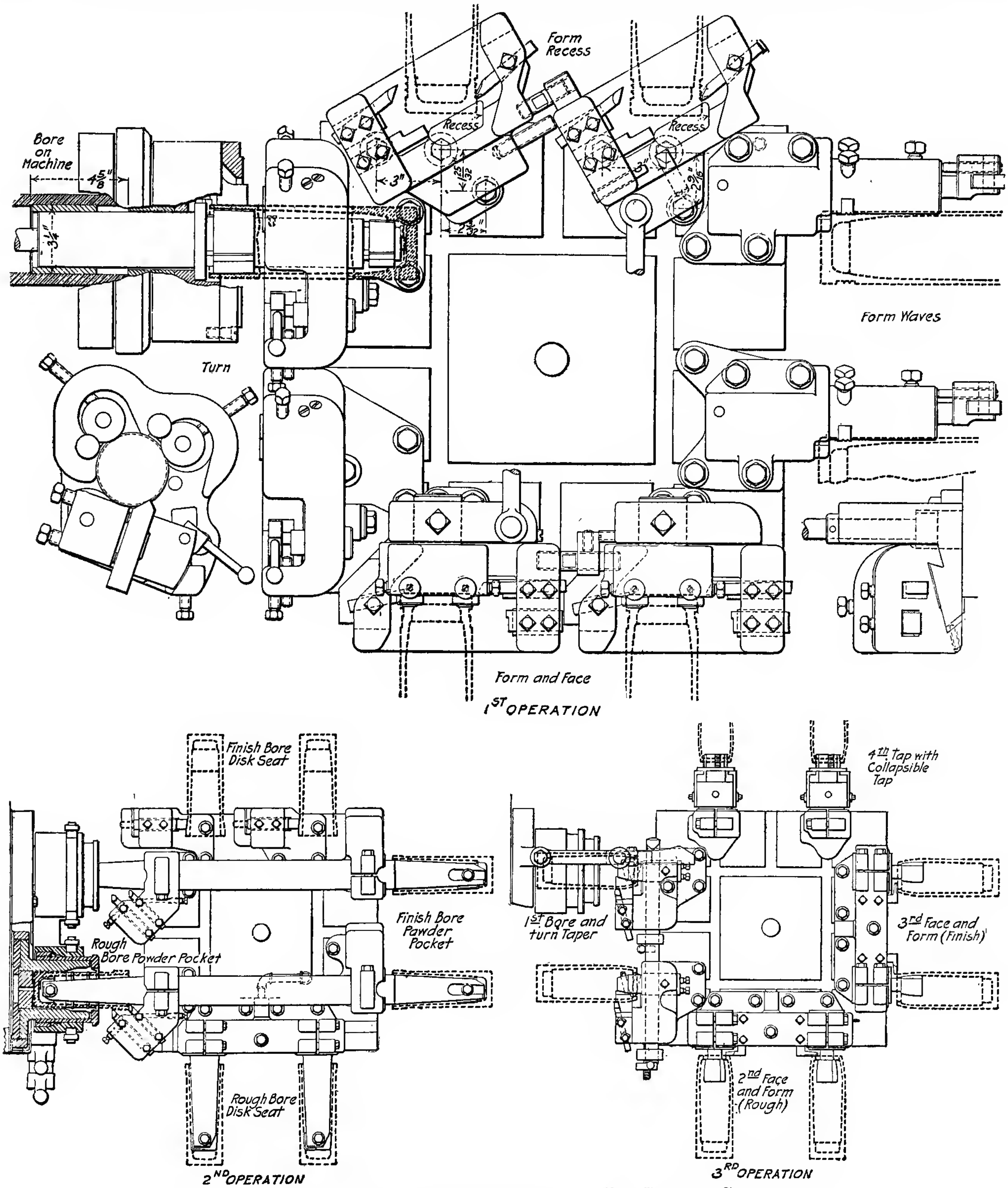


FIG. 2. FLAT-TURRET OPERATIONS ON THE 18-LB. BRITISH SHRAPNEL

thickness of the shell wall just below the threaded end of the nose is one of the most particular parts of the entire shell, practically no variation from the stated thickness of one tenth of an inch being allowed at this point.

Some of the tool set-ups as observed in this plant are shown in Figs. 3 to 6. Rough-turning the shell is cared for as indicated in Fig. 3. The recess is formed and the end of the shell is faced with the tool set-up illustrated in Fig. 4. The waves are cut with a pair of waving tools similar to that used in the single-spindle machine and illustrated in Fig. 5. The undercutting of the recess is done with tool blocks and tools arranged as in Fig. 6.

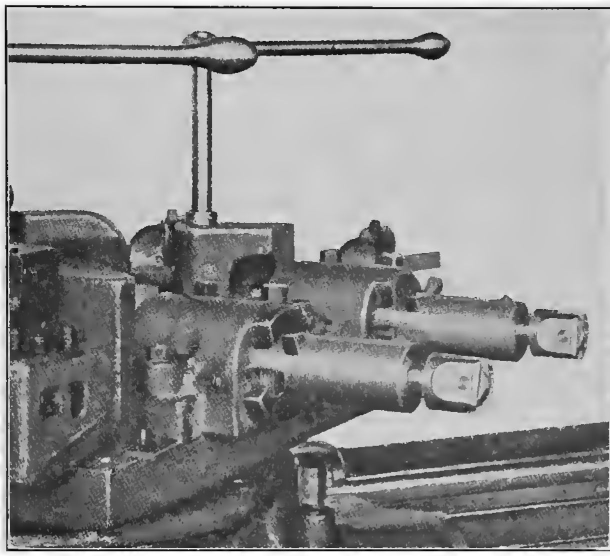


Fig. 5. The Waving Tools

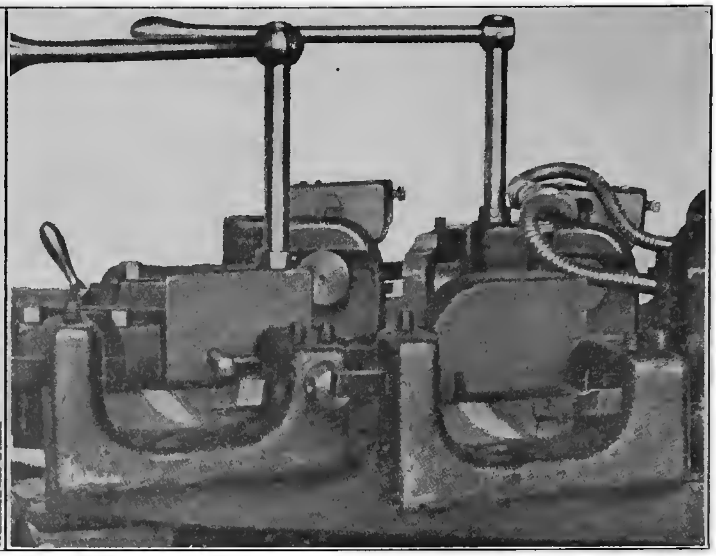


Fig. 6. Tools for Undercutting the Recess

The production of cases on the double-spindle machine runs about 60 per cent. greater than for the same set-up on the single-spindle. Eight shells per hour are considered in this plant an average output for two double-spindle flat turrets, including all three operations.

Demands of War on Industry

A few facts are being set before us, which give a hint of the tremendous demand that war makes upon the producing capacity of a nation.

A French engineer reports that he has seen carload after carload of rifles going back from the fighting front in France for repairs, and has said that it is estimated that every soldier actively engaged will require ten rifles a year. Of course, many of those returned are repaired and sent back into service. Records from the maneuvers of some of our state militia show a loss of 10 per cent. of the rifles issued during a 10 or 12 days' encampment. If the loss is as great as this in a few days of training, what must it be in weeks of active fighting?

Based on the known production of the United States Arsenals a factory capable of producing 100,000 rifle cartridges a day is required to supply a single regiment of 1000 men with the service number of 100 cartridges each. In action, all these might be used in aimed shots in 20 minutes.

Turning to shells for the larger guns, it is said that the French fired one hundred and fifty thousand 75-mm. shells in the battle of the Marne. Their 75-mm. guns can shoot 16 shells per minute, and there are guns which have records of having shot 2000 shells in a single day. At the first of this year, the French government was just completing its equipment to produce 200,000 explosive shells per day. A plant now under construction in Paris is to have a capacity of fifteen thousand 75-mm. shrapnel shells per day. At the rate mentioned, eight of the French 75-mm. guns could fire all the shells produced by a factory employing say 4000 to 5000 men.

These figures apply solely to ammunition and do not hint at the enormous supplies of other army materials. When measured in labor hours, these figures are astounding and beyond our mental realization. But they do give us a hint as to the tremendous strain upon the manufacturing equipment of the countries now producing war material. They also show the sound sense behind the action of the last United States Congress authorizing the development by the War Department of a corps of civilian engineers, a part of whose duties will be the production of ammunition and war material, if this country ever faces war.

Much has been written in the daily press in regard to the enormous amount of ammunition, explosives and guns that has been shipped from this country to Europe. These statements, and the arguments based on them, lose much of their force when we glance at the actual facts.

Comparatively speaking only a small amount of war munitions has been shipped from the United States during the nine months' period—July 1, 1914, to Apr. 1, 1915. The total value of these shipments is $21,980,371 from official United States Government statistics.

The totals of general classes that go to make up this amount are as follows: Fire-arms, $6,994,165; cartridges, $9,570,077; other explosives, $5,416,139.

According to customs classification, loaded shrapnel is classed as explosives and unloaded sharpnel as "all other manufactures of iron and steel." The amount of shrapnel included in the last item cannot be separated. But it is of interest to note that the total of this classification for the first nine months of the present fiscal year is considerably lower than for the corresponding periods of 1913 and 1914. The totals are as follows: 1913, $15,-020,000; 1914, $13,558,000; 1915, $11,068,000.

A Bridge Shop Transformed into an Arsenal

Editorial Correspondence

SYNOPSIS—The Dominion Bridge Co. of Montreal, Canada, has devoted one department in its large plant to the production of 15- and 18-lb. British shrapnel. The tool equipment was purchased solely with a view of handling this work effectively, and the arrangement of machines in the shop was made with the same end in view. Jones & Lamson flat-turret lathes are used for the principal operations, and their tooling and action are described in this article.

Among the many shops in Canada which are at present engaged in turning out shrapnel shells, the Dominion Bridge Co. occupies an interesting and unique position. The entire arrangement of the department which they have devoted to this work has been made with the idea of turning out shells rapidly and accurately with as little back tracking and lost motion as possible. It is quite a radical departure to jump from the production of bridges and bridge girders to the manufacture of shrapnel cases, with their close limits, and it is rather remarkable that such a metamorphosis could have been perfected within a few months.

The General Arrangement of Machines

The general arrangement of the machines in the shell department is indicated in Fig. 1. There are 24 Jones & Lamson flat turrets arranged to take care of the principal operations. These machines comprise the most in-

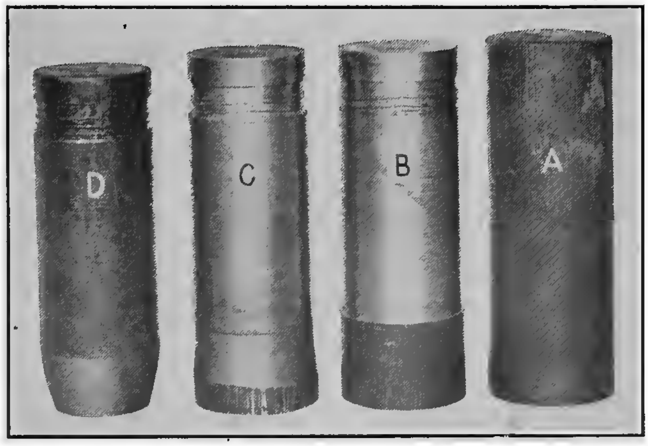


Fig. 2. The Rough Shell (After End Is Cut Off) and the Three Flat-Turret Operations

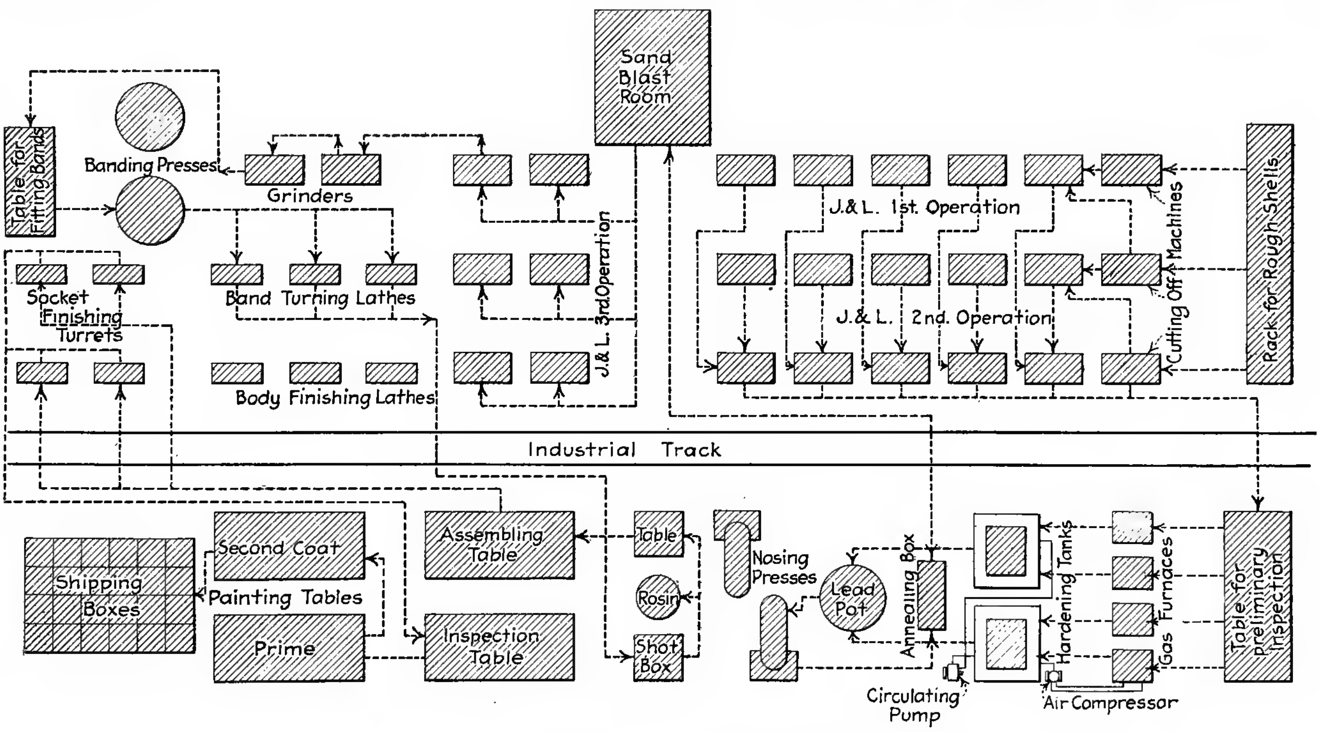


Fig. 1. General Arrangement of Dominion Bridge Co.'s Plant

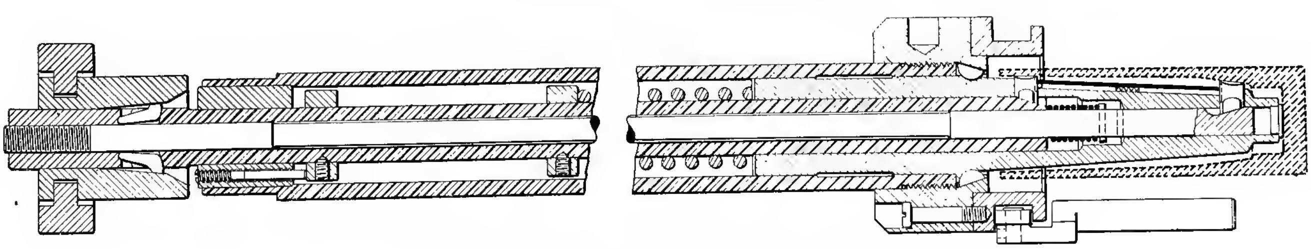


Fig. 3. Details of the Centering Mandrel

teresting part of the tool equipment, and it is with them that this article will largely deal.

A résumé of the general course of work, from the rough forging to the finished shell, may, however, help to make clear the flat-turret operations. The system can readily be followed by means of the diagram of plant arrangement shown in Fig. 1.

The shells are first cut off and rough-faced on improvised cutting-off machines, which formerly served in the capacity of thread cutters. They next go to the first-operation flat turrets, where the work on the outside of the case is cared for; then to the battery of second-operation machines, where they are bored. After this the shells are taken to an inspection table, where they are given a preliminary inspection before heat-treating so that defective shells may be discarded without incurring further expense.

The next operation is the heat treatment, gas furnaces being used for the purpose. This is somewhat outside of customary practice, but it leaves the shell in first-rate condition with very little scale. The hardening tanks contain whale oil, which is circulated and cooled in coils running through inclosing water tanks. In addition

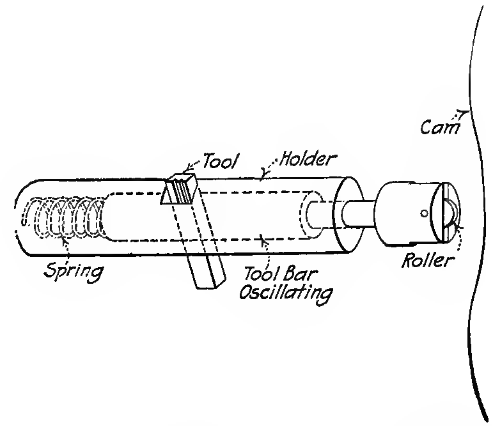
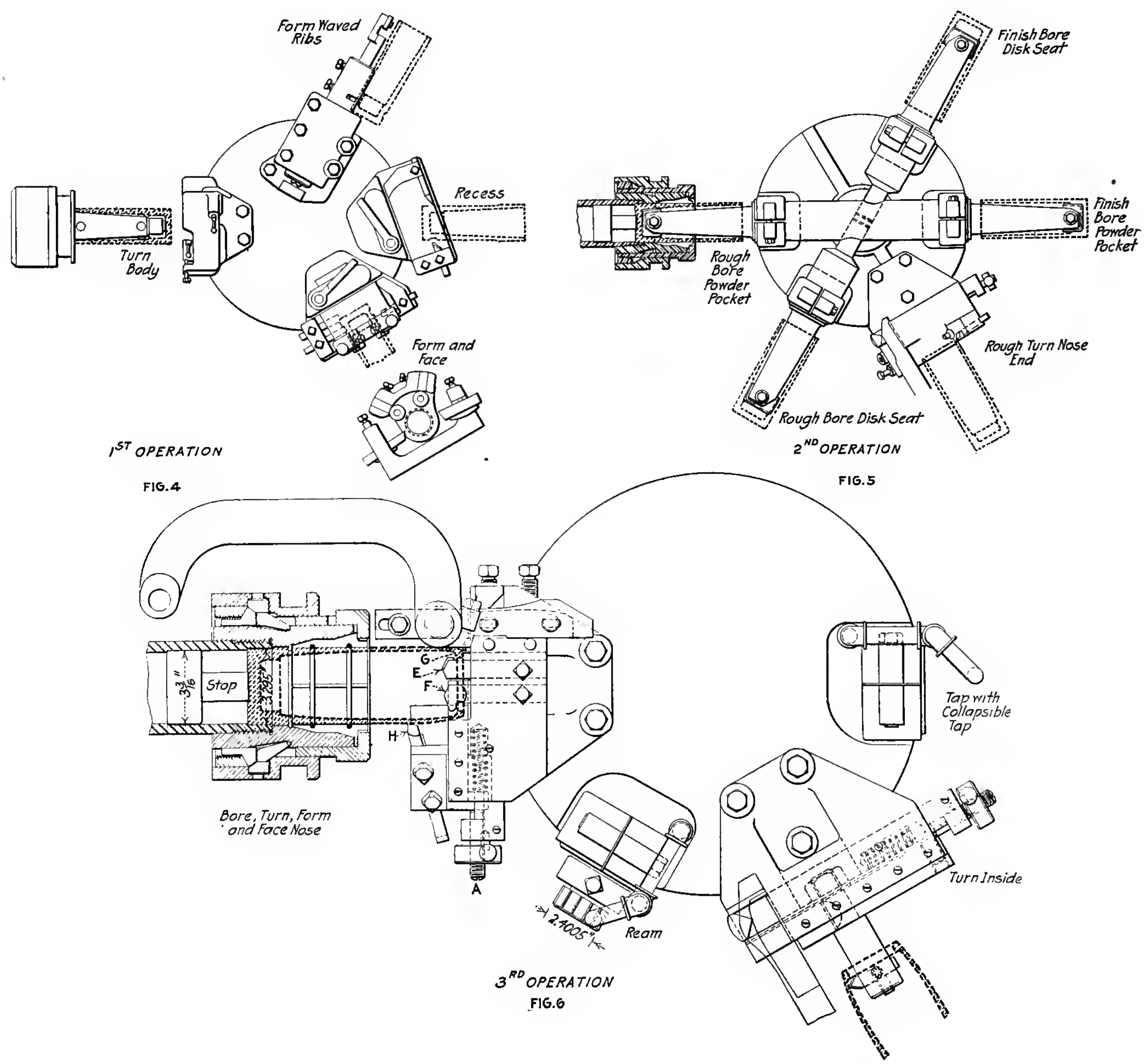


Fig. 7. The Waving Tool and Holder



Operations in Making 18-Lb. British Shrapnel Cases

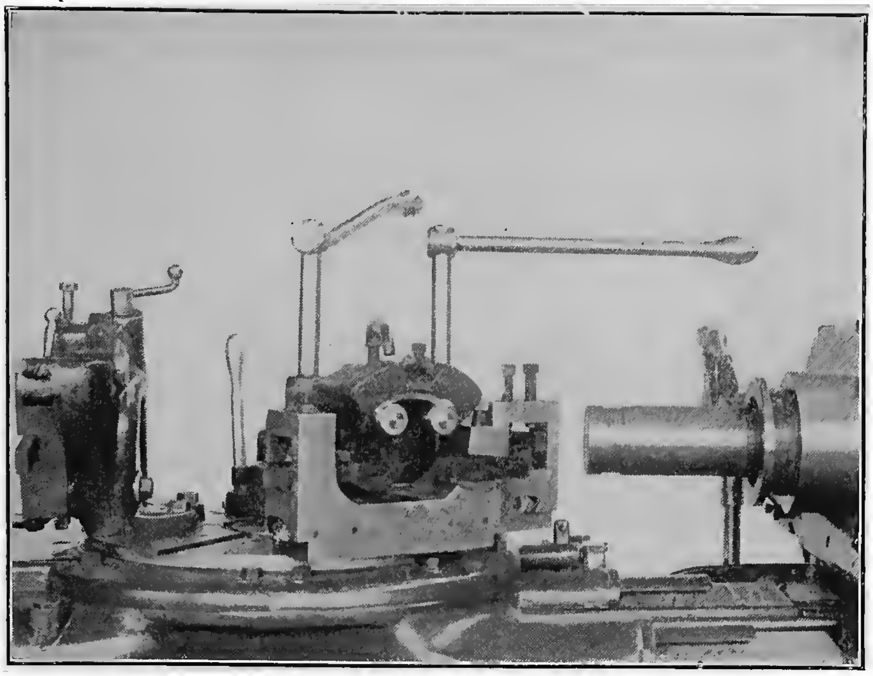


FIG. 8. THE SET-UP FOR THE FIRST-OPERATION ON THE FLAT-TURRET LATHE

to this it is found necessary to agitate the oil by means of compressed-air jets.

Following this heat treatment, the noses of the shells are brought to a low red-heat by immersion in a lead pot, after which they are "bottled" under a punch press. The chill produced by this process is removed by annealing, after which the shells go to the sandblast room, where the recess which contains the "wave" is cleaned out.

Next comes the third flat-turret operation, in which the inside and outside of the nose are machined. From here the shells go either to grinders or to body-finishing lathes—both processes being employed at present—where the outside and the curved nose of the shell are brought to the correct finished sizes. The copper driving bands are next fitted and squeezed, after which the shells proceed to the band-turning lathes, from there going to the filling department, where they are filled with shot and rosin and have the fuse socket screwed home.

The next operation is finishing the socket, which is cared for on brass-finishing turret lathes. Next comes the final inspection, after which the shells are painted and shipped.

THE FLAT-TURRET OPERATIONS

An inspection of Fig. 2 shows the various stages of the shell as it comes to and goes from the flat-turret lathes. At *A* is the rough shell with its end cut off, *B* represents the completion of the first operation, *C* shows the shell bored and turned taper, and *D* represents the completion of the third flat-turret operation, in which the inside of the nose is completed and the outside is roughly shaped.

F. C. MacDonald, plant engineer, is entitled to much credit for the ingenious tooling of these turret lathes. One of the most difficult problems is to securely grip the shell internally for the first operation. Fig. 3 shows the construction of the driving and centering arbor which was finally devised for this purpose.

A DIFFICULT OPERATION HANDLED SIMPLY

The action of the flat turrets may be followed very readily by inspecting Figs. 4, 5 and 6, in which the successive operations are represented by diagrams. The most interesting part of the first operation is undoubtedly the forming of the waved ribs. An idea of the nature of the wave may be had from Fig. 10. At first sight this looks like a difficult operation, but it resolves itself finally into a very simple one. The construction of the tool used for this purpose is shown in Fig. 7. It operates when the roller is forced against a wave cam mounted upon the chuck of the machine. An idea of this operation is conveyed from Fig. 9, which shows the tool in position.

The second operation set-up is also illustrated in Fig. 11. This operation roughs and finishes the powder pocket and disk seat, and also turns the outside of the nose-end taper for purposes of bottling.

REINFORCED BORING BARS

The construction of the boring bars is rather unique and is illustrated in Fig. 16. It will be noticed that a solid bar extends clear across the turret through two tool holders, thus giving an extremely strong construction as compared with the ordinary single support. The other

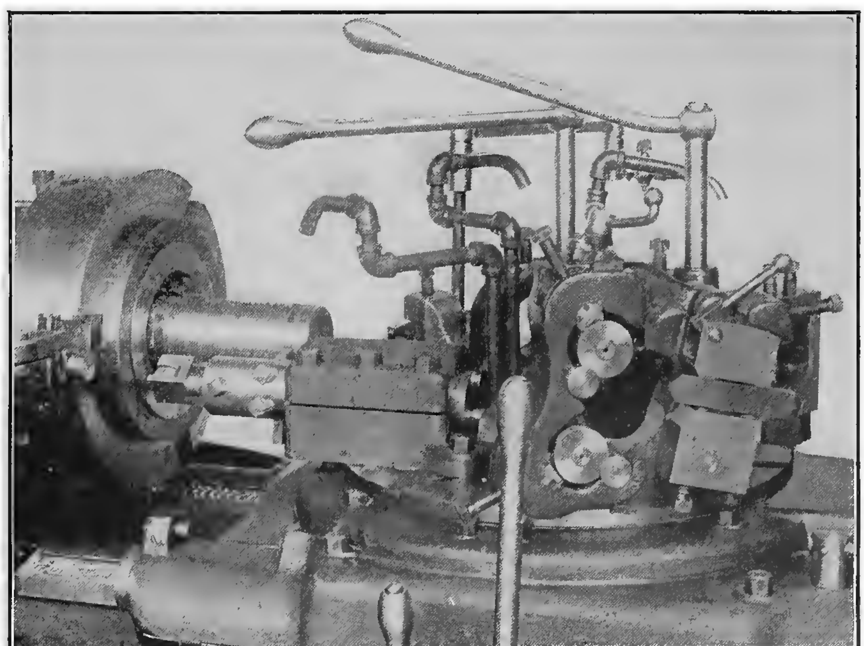


FIG. 9. CUTTING THE WAVE

two bars obtain a similar support by being mortised into the large bar at their shank ends.

One of the short bars used for this purpose is shown at *A*, Fig. 15, and at *B* and *C* finishing cutters for the powder pocket and disk seat are shown. The roughing cutters are quite similar, except that they are gashed for chip clearance.

The third operation on the flat turrets is possibly the most interesting one from the viewpoint of tooling. The set-up shown at *A*, while appearing to be rather complicated, works out well, the curved form of the outside being cared for by a modification of the usual flat-turret taper-turning device.

The tool block used for this operation is also shown in Fig. 15, the tools being similarly lettered in Fig. 6 for purposes of comparison.

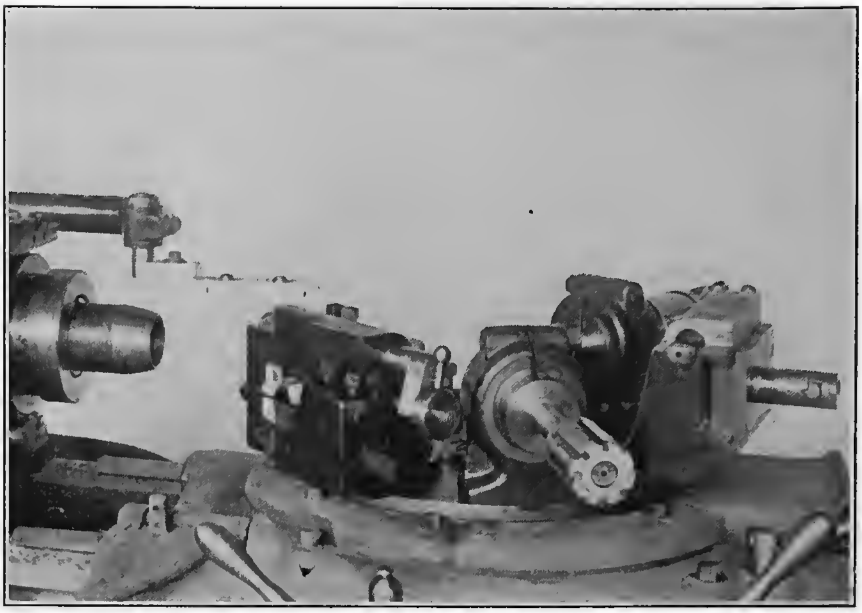


Fig. 12. The Third Operation on the Flat-Turret: Turning the Nose

The method of compensating those who work on shrapnel parts is entirely by piecework. In addition to this their efforts are stimulated by means of a production board on which records of the best runs are posted daily. A facsimile of one day's record is shown in Fig. 13. In the right-hand column of this figure the production has been reduced to a rate per hour for convenience in comparison.

It must be remembered that these figures represent *best runs* and that the average production is somewhat less. The piece prices are figured so that it is possible for the operator to make a good day's pay, and the stimulus of this possibility is manifested in the feeds and speeds of the various machines. Critical inspection is maintained after each few operations to prevent any slighting of the work which would result in the rejection of the shell by the government inspecting squad.

At present the Dominion Bridge Co. is using both grinders and engine lathes for finishing the body and nose of the shell. The method of grinding the body and nose will be fully described in an article to follow, but an inspection of Fig. 14 will give an idea of the method of

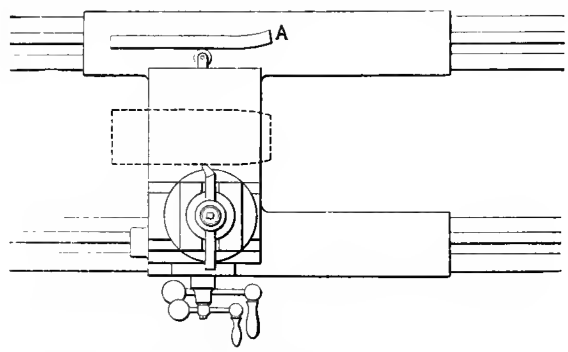


Fig. 14. Arrangement for Finish-Turning the Case on an Engine Lathe

doing this work on an engine lathe. The template *A* is made with the exact shape of the profile of the projectile and a roller on the cross-slide is kept against this by means of a weight, the cross-feed screw being disconnected and tool adjustment made with the compound rest. After being annealed, the shells may be turned at a speed of from 40 to 50 ft. per min. and a feed ranging from 40 to 60 per inch.

A Simple Painting Bench

A simple and effective painting bench is used in this plant for holding the shells while applying the priming and finishing coats. It is shown in Fig. 17 and consists of a number of inclined spindles of such size that the powder tubes of the assembled shells will slip over them. The painter then rotates the shell upon the spindle with one hand while applying the paint brush with the other.

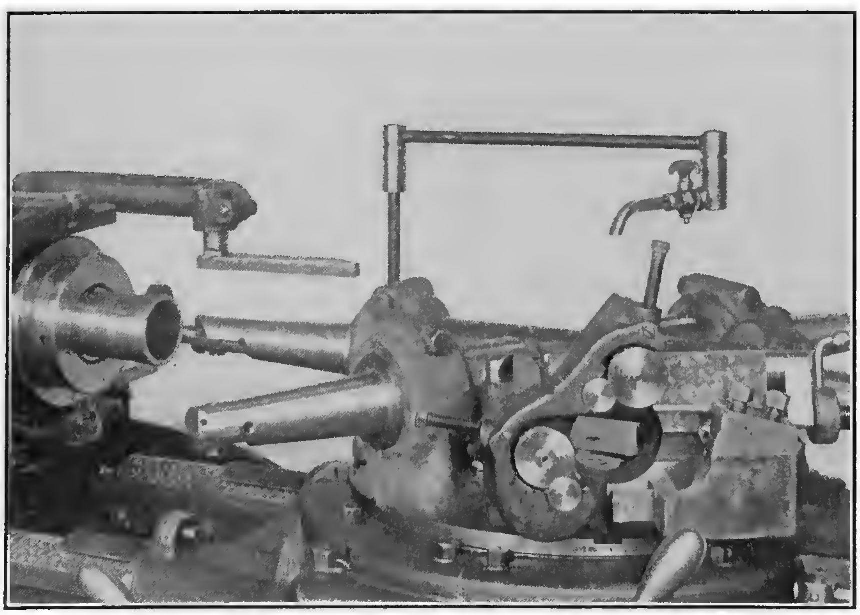


Fig. 11. Boring and Turning Taper. The Second Flat-Turret Operation

Summing up the time on the principal operations as represented in Fig. 13, we obtain a record of 1.06 hours required for the production of one shell. This, of course, is not a maintained rate, but consists in the average of best records only. Also, it omits one or two minor operations, such as sandblasting, annealing, etc.; neither does it include the handling time. But even so it is a most remarkable record considering the short time in which the bridge shop was transformed into an arsenal.

FIG. 10. THE WAVE

PRODUCTION BOARD

DOMINION BRIDGE CO LACHINE, QUEBEC.

RECORD OF BEST RUN FEB. 23RD, 1915

OPERATION	PIECES	HOURS	PRODUCTION RATE PER HOUR
Cut off & Face (1 Operator)	145	11½	12.6 ✓
" " " (2 Operators)	209	21	9.95 ✓
Outside Turn (J&L #1)	59	10½	5.62 ✓
Inside Bore (J&L #2)	140	11½	12.2 ✓
Cutting Fin	88	2	44 ✓
Mark	483	10½	46 ✓
Harden	272	11	24.7 ✓
Swedge Nose	962	21½	44.7 ✓
Turn Nose (J&L #3)	140	11½	12.2 ✓
Finish Turn	101	10½	9.6 ✓
Press Band	430	14½	29.6 ✓
Turn Band	225	10½	21.4 ✓
Assemble	402	57½	7 ✓
Turn Socket	211	11½	18.4 ✓
Paint	335	18	18.6 ✓

FIG. 13. DIAGRAM OF THE PRODUCTION BOARD

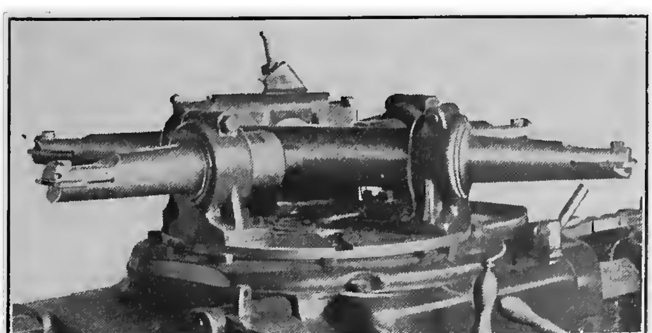


FIG. 16. THE REINFORCED BORING BAR

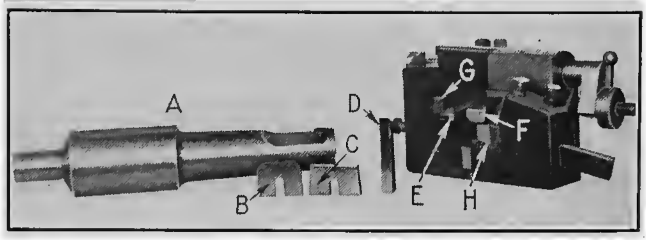


FIG. 15. SOME INTERESTING TOOLS

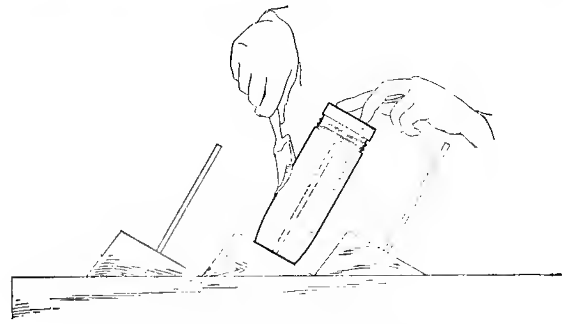


FIG. 17. THE PAINTING BENCH

Machinery After the War

After one has read letters and articles, dealing with the effects of the present war on German industry, it is in order to speculate a little about the conditions which will exist after the war has ended. From the multitudinous and conflicting reports, we believe we are justified in concluding that the following statements are facts:

Many shops and thousands of machines have been smashed in Eastern France, Belgium, Russian Poland, and East Prussia. Automobiles and other vehicles, railroad rolling-stock and merchant vessels, are being destroyed and worn out at an increasingly rapid rate. Much of the machine-tool equipment of Germany will be ready for the scrap heap by the end of the war. The machine-tool equipment of England, France, and Russia is now working twenty-four hours a day and seven days a week, which means rapid wear. If our information is not too highly colored, much of this will be worn out when the war ends. The shortage of skilled labor in all the warring countries must mean that only the most urgent machine repairs are now being made. This is another important factor in machine deterioration. The scarcity of labor is shown by the numerous advertisements appearing in American papers for skilled workmen to go to England and Scotland. England has withdrawn skilled recruits from the army, and Germany has given skilled mechanics furloughs to permit them to return to their shops and work.

From these facts, we seem justified in drawing the conclusion that there must be a tremendous period of shop rebuilding and machine replacement after the war ends. When this period comes, American engineers and American machinery-builders will be called upon to supply much of this new machinery.

Punching Steel Disks for British Shrapnel Shells

By E. A. Suverkrop

SYNOPSIS—In the Dominion Works Plant of the Canadian Car & Foundry Co., Montreal, Canada, steel disks for shrapnel shells are made on a boiler-plate punching machine. The surface, which fits a machined seat in the shell body, is left just as it comes from the hot-forging dies. The work is practically a coining operation performed on hot steel.

The explosive charge of the 18-lb. shrapnel shell is contained in a cup of very heavy tin. The cup is made from two stampings joined by a circumferential soldered lap joint about midway of its height. The lower part is like a shallow cup with a rounded bottom fitting snugly in the machined recess in the base of the shell. The upper part follows the contour of the angular face of the disk and has a vertical flange surrounding a hole in its center. This flange enters a circular depression in the lower side of the disk. Heavy as it is, this cup, without the protection of the disk, would be unable to withstand the enormous crushing force caused by the inertia of approximately 11 lb. of lead bullets when the propelling charge is exploded. This, then, is the duty of the disk: To protect from injury the container of the explosive charge till the explosion takes place.

The stock for the disks is a good grade of low-carbon steel. It comes in bars about 10 ft. long, 2½ in. wide and about $\frac{15}{32}$ in. thick. These bars are heated a number at a time in an oil-fired reverberatory furnace of the regular type.

First Operation

In Fig. 1 from *A* to *E* are shown the five stages of manufacture. The punch and die *F* and *G* for the blank *A* are mounted in a Long & Alstatter double-punching machine with 18-in. gaps.

The bars, being heated to a medium yellow, are taken one at a time. The furnaceman supports the cold end of the bar while the press operator with a pair of tongs locates the hot end over the die, as shown in Fig. 2. The die is a plain cylindrical one, 2¼ in. diameter, made of Sanderson carbon steel hardened in the usual way. The end of the hose *B*, Fig. 2, fastened to the punch *A*, permits a small stream of water to play on it, whence it drips on the die below, cooling them both.

The press is motor-driven and runs, on this operation, a little over 35 strokes a minute. Two men can punch about 3500 blanks in 10 hours.

The dies on this operation play out quicker than the punches, an average die having a life of 2000 blanks be-

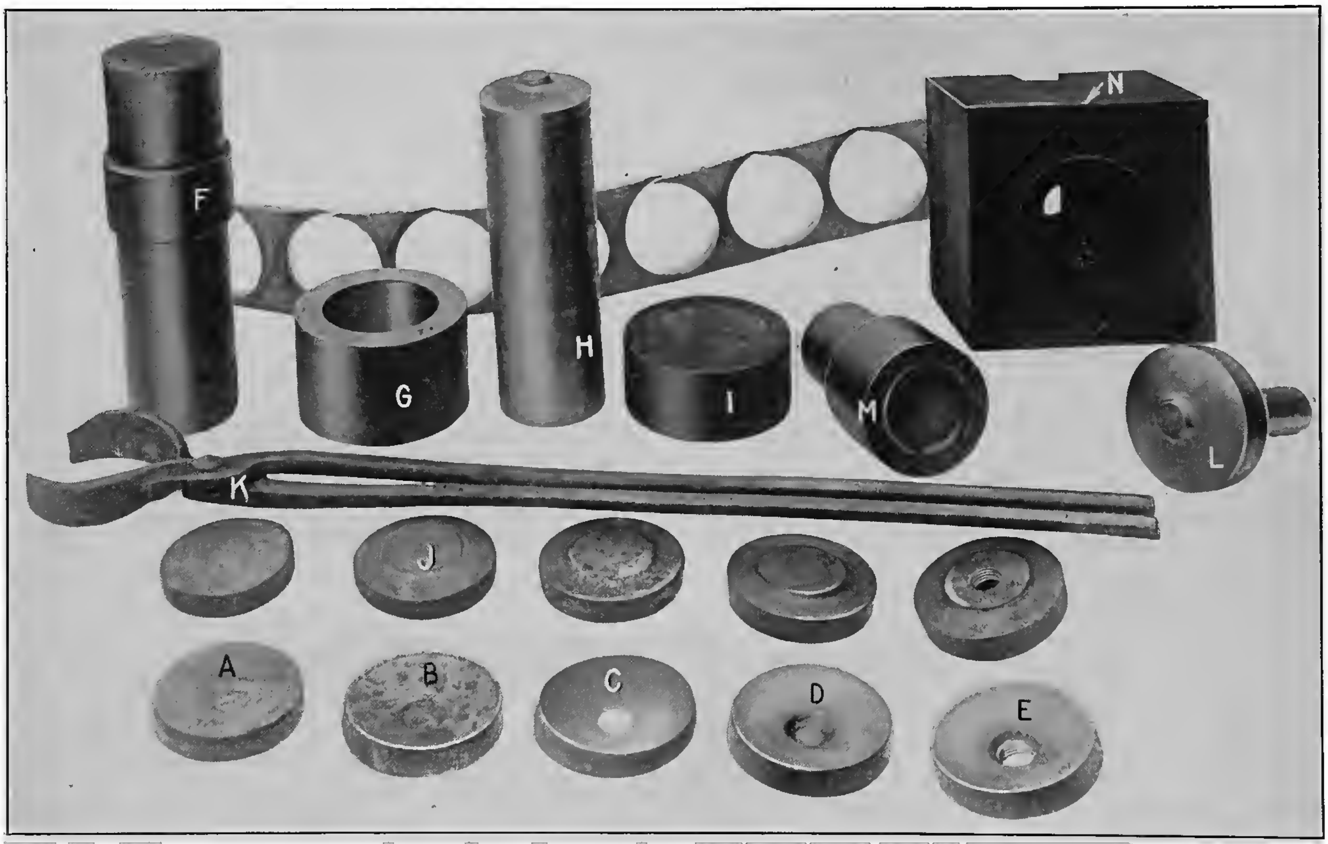


Fig. 1. Tools, Samples of Consecutive Operations and Scrap

fore it requires closing. The punches stand up for about 5000 blanks.

The punches are plain cylinders with conical ends having a teat in the middle. The conical end is of such shape

Fig. 2. Punching the Blanks

as to raise the blanks about $\frac{5}{16}$ in. on the face which enters the die.

Second Operation

In the second operation the blanks *B,* Fig. 1, are squeezed between the male and female dies shown at *H* and *I,* Fig. 1. The lower die has a depression which throws up the raised boss *J.*

A number of the blanks from the first operation are heated at a time for this operation. The furnaceman carries them, when hot, 8 or 10 at a time on a shovel and lays them, with the depressed side up, on the iron trough *A,* Fig. 3.

The pressman handles them with the tongs *K,* Fig. 1. These tongs have light jaws about one inch wide, so that they serve not only for handling the hot blanks, but as a means for locating them in line with the punch. This is done in the following manner:

As the disks lie on the trough *A* with the depressed side up, the pressman in gripping them in the tongs allows the jaws to rest on the iron trough before gripping a blank. The blank is gripped by the lower edges of the wide jaws, which rise on each side like a vertical flange around it.

The work is then swung to the upper die and located under and in alignment with it by the vertical flange (of the jaws), which surrounds not only the work but the upper punch, as shown in Fig. 3. When the punch descends, the work is squeezed between it and the lower die, and on the return of the punch the pressman closes the jaws on the finished second-operation blank and tosses it into a barrel.

The dies in this operation are made of the same brand of steel as those in the first operation. This operation is not as severe on the dies as the first, and from 6000 to 7000 pieces can be obtained from both upper and lower dies.

The press in this, as in the first operation, runs continuously, but the output is less, about 2800 being the average production for ten hours. Water is also used on the dies in this operation.

Third Operation

After the second operation the disks are tumbled to remove the scale, as they must be clean for the final forging operation. From the tumbling operation they appear as shown at *C* in Fig. 1, the loose scale being removed.

Fig. 3. Deepening the Disks

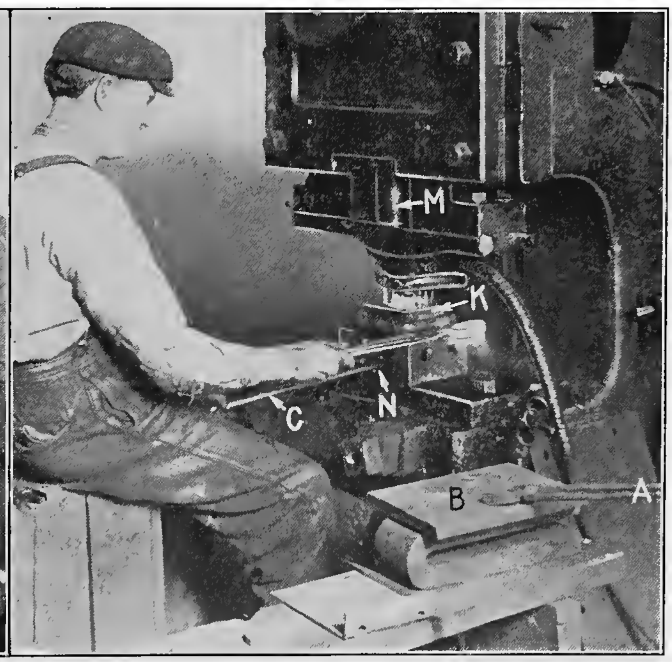


Fig. 4. Coining Operation

This is the final forging operation, and is practically hot-coining done in the die *K.* The knock-out *L* fits a cylindrical seat ¾ in. deep in the bottom of the die. The stem of the knock-out passes through the hole in the bottom of the die, entering the slot N in the bottom. The slot N, $\frac{15}{16}$ in. wide and 1 in. deep, passes from back to front of the die, and a short bar of steel entering it is used as a lever to lift L and eject the work from the die K, when completed.

For this operation the tumbled disks are heated in a furnace and taken one at a time by the long pick-ups A, Fig. 4, and laid on the block B. The pressman takes them and drops them in the lower die K, where they rest on the face of the knock-out. The upper die M descends and squeezes the plastic steel, forcing it to fill the space between the upper and lower dies. On the return of the upper die, the pressman pushes the bar C down with his left hand. Near its outer end this bar fulcrums on the die bolster. The extreme end passes into the slot N in the die and raises the knock-out so that the work can be removed with the tongs.

Fig. 5. High-Speed Steel Die Burst by Rapid Generation of Steam

In this operation the dies are, one might almost say, flooded with water. And the first thought is: How can a piece of red-hot steel be squeezed between dies flooded with water without causing an explosion? This is exactly what did occur with the first die, and the result is clearly shown in Fig. 5.

This die was made from a block of high-speed steel, measuring $4\frac{3}{4}$ by $4\frac{7}{8}$ in. on the bottom and is $4\frac{5}{8}$ in. high. The hole in the die is $1\frac{5}{8}$ in. deep and tapers from $2\frac{11}{16}$ in. diameter at the top to $2\frac{1}{2}$ in. at the top of knock-out, so that at the thinnest part of the wall it is 1 in. thick. This die burst with sufficient force to drive a dent in the cast-iron press frame nearly $\frac{3}{16}$ in. deep. The cause of the explosion, as previously stated, was the rapid generation of steam in the confined space when the dies were closed.

The trouble was obviated in subsequent dies by drilling a $\frac{3}{16}$-in. hole in the knock-out space for the escape of water and steam. The approximate location of this hole is indicated at A, Fig. 5. As this hole is below the top of the knock-out there is no chance of the hot disk being squeezed into it. All the breaks were in solid metal, there being no sign of a flaw anywhere on the fractured surfaces.

On the final operation the dies stand up for about 5000 pieces each before it becomes necessary to close them.

Owing to the fact that uniform heating is necessary for this operation, the pieces are handled one at a time from the furnace to the press. This results in a reduction of output, and only about 1700 finished disks can be produced in 10 hours.

Fourth Operation

After the coining operation the work has a clean "bloom" on the outside, which is left on; that is, the disks are not tumbled after the last forging operation.

The next operation, shown at X, Fig. 8, is done on a Jones & Lamson flat turret lathe. The machine and tools are shown in Fig. 6. The work A is held in an ordinary spring collet. The flat centering-drill B is first brought into action so that the twist drill C will start true. Finally, the tap D is run in. In operation, the attendant chucks a disk with the small part of the taper at the inner end of the collet. The center drill B, twist drill C and tap D are run in in rotation. The tap, however, is not backed out by power. On reaching the proper depth the machine is stopped and the turret drawn back with the tapped disk still on the tap. The operator chucks another disk and repeats the operations as before, but while feeding the twist drill in with his right hand, with the left he removes the threaded disk from the tap.

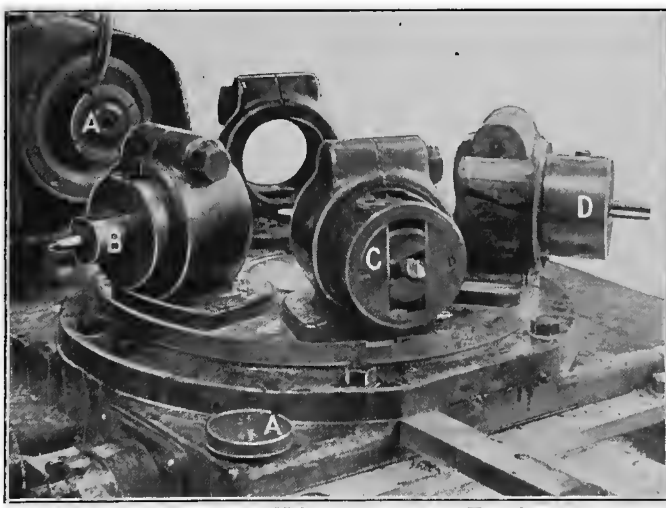


Fig. 6. Centering, Drilling and Tapping

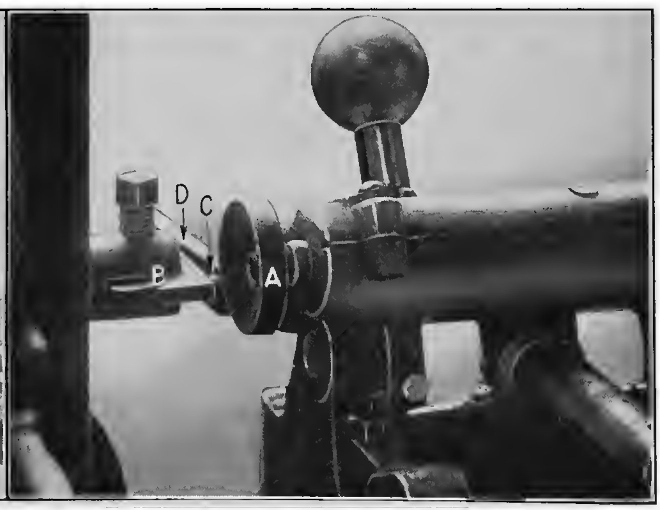


Fig. 7. Facing and Burring

The disk must be carefully chucked, for the tube which screws into it must be square with the seat, otherwise it will be cocked over and trouble would ensue when the shell is fired, due to the inertia forcing the disk to seat properly, with resultant distortion of the tube or powder cup or both.

On this operation 600 can be produced in 10 hours.

The fifth and last operation is performed on a D. E. Whitton double-spindle centering machine, although in this operation only one spindle is used.

The work *A* is screwed on the rotating spindle. The spindle and work are advanced by a lever, not shown. The facing cutter *B* removes the slight burr raised around the edge in the last forging operation by the metal entering the space between the knock-cut and the lower die,

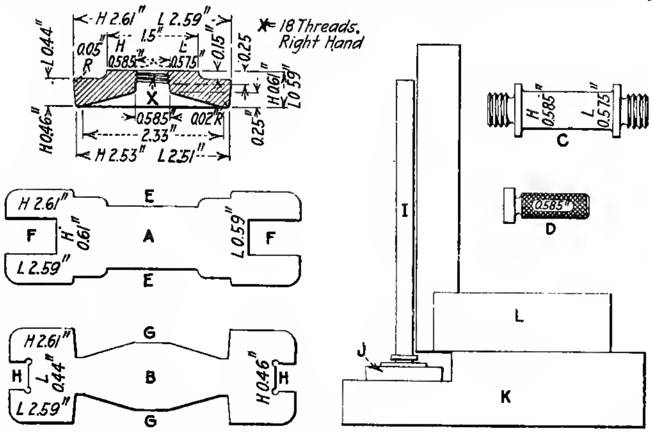


Fig. 8. Making Steel Disks for Shrapnel Shells

and also finishes the slight flat surface required on the lower edge. The operator also gives the other edge a touch with a file to remove any slight burr formed at the space between the upper and lower dies. Pivoted on the pin *C* is a lever *D* with the front end provided with a toothed cam for holding the disk while removing it from the spindle.

The production of the burring and facing operation is 1000 in 10 hours.

Inspection is rigid on the disks. The requirements are fairly close, if one takes into consideration the way the pieces are produced. The tolerance of 0.02 in. would perhaps be considered large for a re-striking operation in an uptodate drop-forge shop; but it must be remembered that this is an ordinary blacksmith shop, where large rough work has been produced and the machine used is intended for the usual run of plate punching. In Fig. 8 are shown the work, in section with dimensions, and the inspection gages.

The gage *A* (about 1/8 in. thick) at *E* is for ascertaining the shape and diameter of the disk top and at *F* the total depth of the disk. The dimensions being given, the application of the various gages to the disk will be apparent.

The gage *B*, also 1/8 in. thick, is for ascertaining at *G* the shape and diameter of the base of the disk (note the flats in the corners of the openings *G*). At *H* the thickness of the edges of the disk is gaged. The gage *C* is a thread gage for the central threaded hole. The plug gage *D* is for the recess which receives the top of the powder cup.

Having passed these inspections a tube is screwed into a disk *J*, as shown in Fig. 8, and with the disk *J* resting on the lower level of the two-surface plate *K*, is tested for squareness with the square *L*.

Owing to the inequality in thickness of commercial bar stock, disks are occasionally found, on inspection, to be too thick. These are returned to the smiths' shop and re-struck, the excess of metal flowing into the tapped hole in the center, from which it is removed in the rethreading operation.

A Lathe for Shrapnel Manufacture

By H. V. Haight*

The experience of our people in making the 18-lb. British shrapnel has shown up many faults in ordinary lathes. Before taking up these faults, however, let us consider for a moment the manufacturing method used on this work, which has given very satisfactory results.

Mr. Van Deventer referred to this when he said, "There are two widely different principles in quantity manufacturing, each of which has its apparent advantages and supporters. These are nowhere any better illustrated than in the manufacture of shrapnel shells. Some believe in putting as many operations as possible on one machine; others, in *reducing each operation to its lowest terms.*"

Now, in the case of shrapnel, I feel very sure that they can be made for as low labor cost and at much less capital expenditure on plain lathes with home-made attachments, instead of using the special lathes so widely advertised for the purpose. But one difficulty seems to be that no one is making the plain lathes that are required for this purpose. I do not like to call them engine lathes, for there are so many features of an engine lathe that are not required. Perhaps "Manufacturing Lathe" would be a better name.

The first is belt power. To illustrate, we are turning shrapnel on a big turret lathe of 24-in. swing and having a 5-in. hole through the spindle, yet neither the belt drive from main line to countershaft nor that from countershaft to lathe spindle would carry without trouble a good cut on a 3½-in. diameter forging. Can the American Machinist produce some rules for the belt power of a roughing lathe?

The second requirement is a good countershaft. As has often been said most of the frictions are a poor lot. On this shrapnel work, some of the friction clutches were so poor that we replaced them with tight and loose pulleys. The oiling systems of most countershafts are primitive, and when repairing the shafts we sometimes find them worn down one-eighth of an inch. Nearly all of the countershafts have given trouble.

The third requirement is a stiff spindle. For example, we are turning 3⅜-in. copper bands on a 28-in. lathe, because the spindle is big enough to prevent the work from chattering. But a 28-in. lathe is a heavy, clumsy thing to handle on work that is finished in one minute. If someone would offer a 14-in. lathe having a 5-in. spindle with a 3½-in. hole, it would be just the thing for the job. Didn't one of your correspondents, some years ago, propose a roughing lathe with a spindle diameter equal to one-half the swing of the lathe? We are going to try a cutting-off machine, which looks promising. Another shrapnel manufacturer built a special lathe with a big spindle and is getting good results.

A fourth requirement is a stiff tailstock. As an instance, in rough-turning shrapnel we try on some lathes to make up for the lack of stiffness in the driving spindle by supporting one end of the work with the tailstock. But a tailstock spindle 1$\frac{15}{16}$-in. diameter and sticking out 6 in. from the body of the tailstock gives a very flexible support. We are making a new tailstock.

The above four essentials may be condensed into two—power in the drive and stiffness in the holding spindles.

*Chief Engineer, Canadian Ingersoll-Rand Co.

Tin Powder Cups for 18-Lb. British Shrapnel

By J. H. Moore

SYNOPSIS—The tin powder cup is an essential part of the 18-lb. British shrapnel. This article describes the process employed in making these cups and shows the punches, dies and other fixtures that are required.

In outlining the operations incident to the manufacture of the powder cups for 18-lb. British shrapnel, it might not be amiss to mention at the start that the cup is placed in the receptacle near the bottom of the shrapnel shell and that it contains the explosive. From the cup a copper tube is led through the center of the shell body until it reaches the fuse socket, in which position it is ready for the attachment of the timing fuse when the shell is desired for use.

As these shells were originally manufactured in England, the stock specified by the government is English

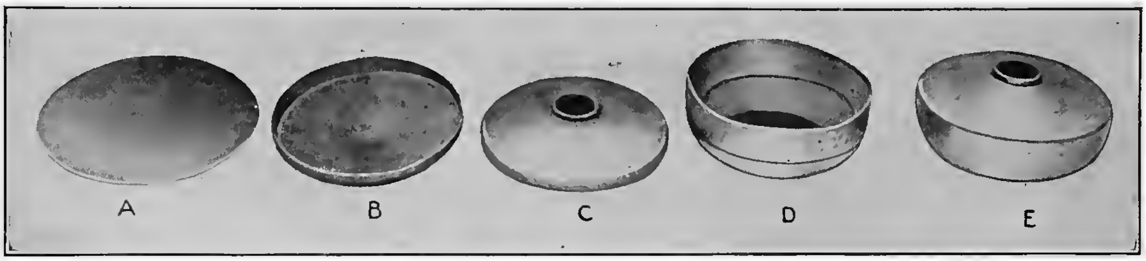


Fig. 1. Steps in the Process of Making a Tin Powder Cup

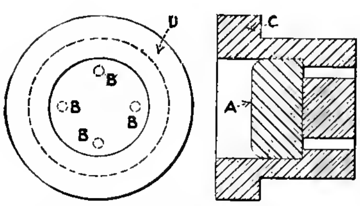


Fig. 2. Bottom Die Used for Drawing the Powder-Cup Bottom

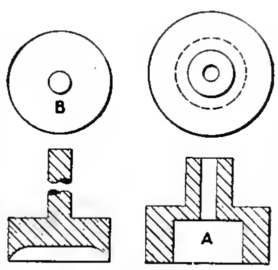


Fig. 3. Punch Used in Drawing Powder-Cup Bottom

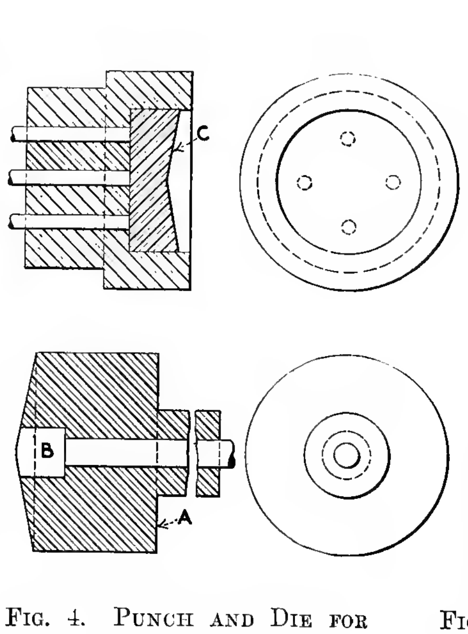


Fig. 4. Punch and Die for Powder-Cup Top

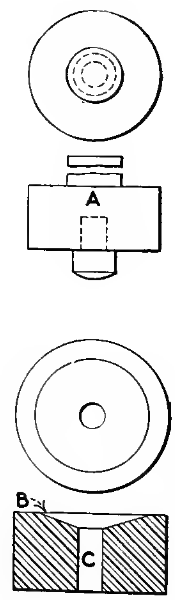


Fig. 5. Flanging Tools

gage. This has caused an enormous amount of annoyance and inconvenience, as it is very difficult to procure the correct thickness in this country. The two thicknesses are; for the bottom portion, 0.022 in., and for the top, 0.036 in. This tin must be heavily coated and of good drawing qualities; otherwise it would rupture and be good only as scrap.

Drawing the Cup Bottom

The bottom of the powder cup is completed in one operation, and the die-blanking and drawing in one stroke of the press. In Fig. 1, at *D* can be seen the shape of the bottom after coming from the press. The bottom die for this operation is shown in Fig. 2. Here *C* represents the die itself; *A*, the ejector, and *D*, the form block, which is operated by four pins through the holes *B*. These pins come in contact with a rubber stripper underneath the press, which is of the usual type. The upper punch is shown in Fig. 3, *A* being the punch and *B* the drawing block. These punches and dies complete the bottom portion.

Forming the Top

The first operation on the top requires a straight blanking die, and as this is an every-day proposition I have not illustrated it.

The second operation dies for forming the top, are shown in Fig. 4. In this, *A* represents the upper form punch; *B*, the knockout pin operated from the upper stripping attachment on the press, and *C*, the lower form die and ejector. The illustration shows this die clearly.

The third operation is the piercing of the top hole to take the copper tube, and this again being an exceedingly simple operation is not illustrated.

The fourth and last operation is that of making the small flange on top, and the dies shown in Fig. 5 will clearly illustrate this work, *A* being the upper form punch with the flange-forming punch inserted; *B,* the lower die, and *C,* a hole of sufficient diameter to allow the forming of the flange.

By referring to Fig. 1, we can follow the steps of the process. At *A* the blank for the top portion is represented; *B* shows the blank after the forming operation, and *C* represents the blank after being pierced and flanged. The finished bottom portion is shown at *D,* and *E* represents the finished tin cup.

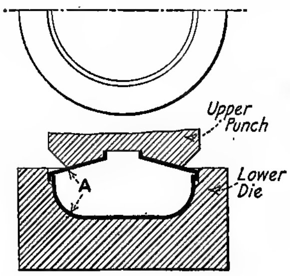


FIG. 6. ASSEMBLING THE TIN CUP

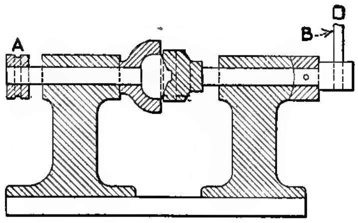


FIG. 7. ELEVATION OF SOLDERING MACHINE

ASSEMBLING THE POWDER CUP

The next step is that of assembling, and for this work, a die simliar to that shown in Fig. 6 is used. The tin cup is shown at *A.* These dies can be placed on power prwesses or even on lever foot presses, as some manufacturers are doing.

There is one remaining operation, that of soldering, and perhaps one of the easiest and quickest methods employed is that shown in Fig. 7. This soldering machine is attached to a bench, being driven by a rope from the sheave pulley *A.* There is a quick-action releasing attachment on the handle *B* to permit of taking out and replacing the tin cups. After being inserted, the cups revolve and the operator merely holds his iron to the work as it turns around. Experiments are being tried to make this soldering automatic, and perhaps before long this will be also accomplished.

Soldering completes the cup with the exception of inspection, as the loading of these is done at the government arsenals, the various manufacturers having nothing to do with this.

Flechettes

By C. J. Booth

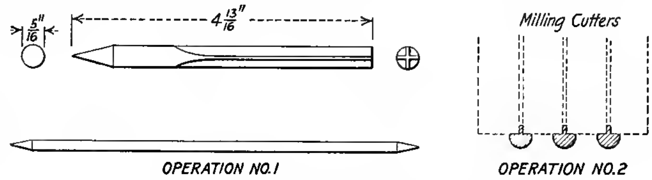
We have recently been producing large quantities of the flechettes, or aërial arrows, shown in the illustration. These are dropped from aëroplanes as they pass over hostile troops and are said to be very effective in cases of masses of men.

These arrows are made from ordinary mild steel, $\frac{5}{16}$ in. in diameter and are $4\frac{13}{16}$ in. in length. The head is pointed, and the body is milled away so that the remaining section is in the shape of a cross. The point is not hardened, but care has to be taken that it is axially in line with the center of the cross at the opposite end. The quantities required are prodigious, one contract alone being for no less than fifty millions every three months.

The production of these aërial arrows does not present any manufacturing difficulties, except in completing them quickly and cheaply enough. The method adopted is as follows: Bright mild-steel bar of the correct diameter is passed through a small automatic machine, which is usually employed for making small bolts and screws, and the material is cut off in lengths equal to the length of two arrows plus the thickness of a subsequent saw cut, being pointed at each end. These are then taken to a horizontal miller, where they are held in a jig in rows of eight, and a gang of milling cutters is passed over them. This completes one-half the milling required, each cutter (except, of course, the outside ones) milling two grooves in two pieces, that is, in four arrows.

The next operation is the milling of the two remaining grooves on the opposite sides of the arrows. The jig was so made that the part in which the ends of the arrows were locked could be removed bodily from the base, turned over without interfering with the arrows, and replaced with the reverse side up, being heavily doweled for this purpose. This scheme works admirably and is exceedingly rapid.

The subsequent operations are parting off in the center with a little circular saw, and a final inspection, during which burred edges and fins are removed with a file. The actual working time per arrow averages only three minutes.



THE WORK AND MILLING METHOD

A Possible Deciding Factor

A possible deciding factor in the present European war may be the exhaustion of the machine-tool equipment of the hostile nations.

This is essentially a war of machines, and as the fighting machines are made with machine tools, the basic resource must be the machine-tool reserve. Thus when exhaustion comes in that place, there must come the cessation of hostilities, even if other factors have not previously intervened.

We do not know with any accuracy the condition of the machine-tool equipment of the belligerents. But from general considerations we know that it must be strained to the uttermost. It must be wearing out faster than ever before in the history of machinery building in any nation and at any time. The addition of new machine tools is a comparatively small factor. During the last eight or nine months the United States has only doubled its usual amount of exports. And while this is an important factor in the machine-tool business of this country, it is not a large factor when considered beside the value of the equipment that existed before the war began.

The exhaustion of machine-tool equipment is of course a long process. It is a matter of years rather than months or weeks. But such exhaustion can finally come as well as any other.

The Manufacture of 18-Pounder Shrapnel-Shell Sockets and Plugs

By J. H. Moore

The manufacture of sockets and plugs for 18-pounder shrapnel shells has not, to my knowledge, been adequately treated up to the present date. For this reason, I will describe the methods employed in making these two parts.

The socket is placed in the mouth of the shell and turned to the desired shape. It is made from a very cheap alloy, consisting of 50 per cent. copper, 40 per cent. zinc, and 2 per cent. lead. This metal is so poor that it has been found practically impossible to make satisfactory castings. They must, therefore, be forged to the desired form from slugs. For this purpose a 300-ton knuckle-jointed press is used, as the pressure necessary to complete this work is enormous. A dry furnace for heating is generally used, gas being the heating medium. Some, however, prefer the lead bath for this part of the work. Either is satisfactory, though the gas furnace is a shade the best, as, with the bath, the lead usually gets into the dies. The slugs are placed in this furnace, and withdrawn at from 1200 to 1400 deg. *F.* At this temperature they flow easily and are not liable to rupture.

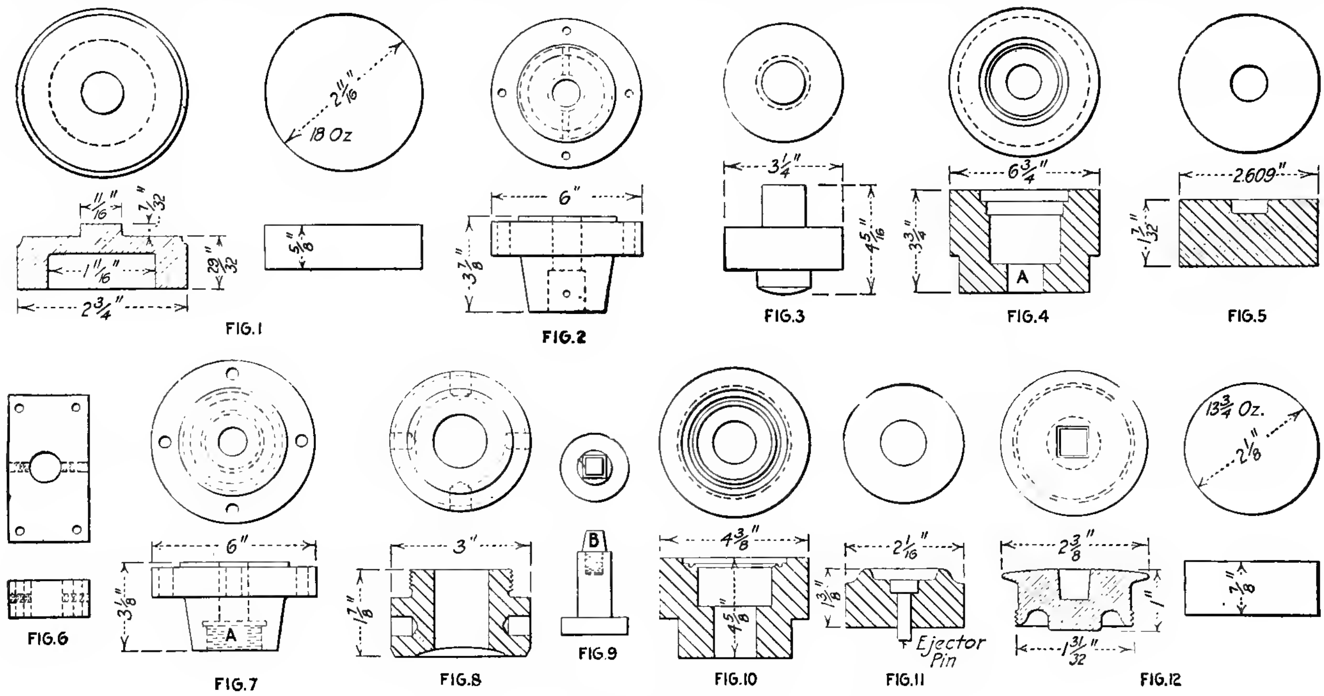
In Fig. 1 is shown the socket before and after forging. The slug is $2\frac{11}{16}$ in. diameter, $\frac{5}{8}$ in. thick and weighs 18 ounces. This will give some idea of the displacement of the metal. The dies, with the exception of the lower bolster, are shown in detail in Figs. 2, 3, 4 and 5. The lower bolster is shown in Fig. 6. In Fig. 2 is indicated the type of top die, or punch holder, used, while Fig. 3 illustrates the top punch. In Fig. 4 the lower die for forming is shown, and in Fig. 5, the ejector block which goes into this die. This ejector is operated on by an ejector rod, which comes through the hole *A,* Fig. 4. One blow completes the form, and the output of one press and furnace, with two men working, reaches approximately 4000 per 20-hr. day.

The Fuse Plug

The fuse plug is the portion screwed into the socket just described. It is made from the same alloy. When the shells are desired for use in actual warfare, this plug is unscrewed on the battlefield and thrown away.

As the forging of this piece is practically the same as that described, the dies only will be shown. The top punch holder is shown in Fig. 7. In Fig. 8 is represented the outer sub-punch, to which is added the inner sub-punch, shown in Fig. 9. These two punches are screwed into *A,* Fig. 7. The small square punch shown at *B* in Fig. 9 is made from high-speed steel and is designed for easy replacement, as a great many break off while at work. In Fig. 10 is shown the lower form die, and in Fig. 11, the ejector block with ejector pin in place. The bolster plate for both plug and socket dies is shown in Fig. 6, the reason for making the dies interchangeable being to save the removal of this plate from the bed of the press. In Fig. 12 is shown the plug before and after forging, dimensions and weights being given.

The thread shown on the finished work is not done in the forging operation, but is produced afterward on the turret lathe.



Details of 18-Lb. Shrapnel-Shell Sockets and Plugs

A process claimed to make practical the manufacture of steel scrap into manganese-steel articles has been developed by Prof. Henry M. Howe. The process consists in first melting and mixing the scrap and a manganiferous material, such as ferromanganese, containing carbon in suitable proportions to produce the critical ratio between the carbon and manganese in the mixture with a proper allowance for the changes in the proportions of these elements arising from the reactions incident to melting. The proportions must compensate for the loss of manganese by oxidation and the gain in carbon by absorption from the fuel. The ratio having been established, or approximately so, the mixture is diluted with carbon-free iron until the amounts of carbon and manganese bear to the whole the desired relation in per cent. These steps are supplemented by one or more additional operations or treatments adapted to adjust the carbon and manganese with greater precision.

Automatic Production of Shrapnel- and Explosive-Shell Parts

Special Correspondence

SYNOPSIS—In this article are shown the tools and methods used for manufacturing shell head and fuse parts. The same machine is in each case equipped for handling the first and second settings of the pieces. The equipment is such that the parts produced, when two settings are employed, come within a limit of 0.004 in. of being concentric and the threads within 1/8 turn. Most of the parts are manufactured from brass forgings, which enables quick production to be made.

The New Britain Machine Co., New Britain, Conn., is tooling up its multiple-spindle automatic-chucking machines for the manufacture of shrapnel- and explosive-shell head and fuse parts, some of the operations on which are described in this article.

In Fig. 1 is shown a special seven-spindle chucking machine, known as size No. 73, tooled for making the projectile fuse head, Fig. 3. The parts are made of machine steel. The blanks, which weigh 15 oz. each, are received in the form shown in Fig. 2. These parts are finished in one setting, using the tools in the sequence indicated in Fig. 4. These, it will be observed, are threaded externally and internally. The ends are machined.

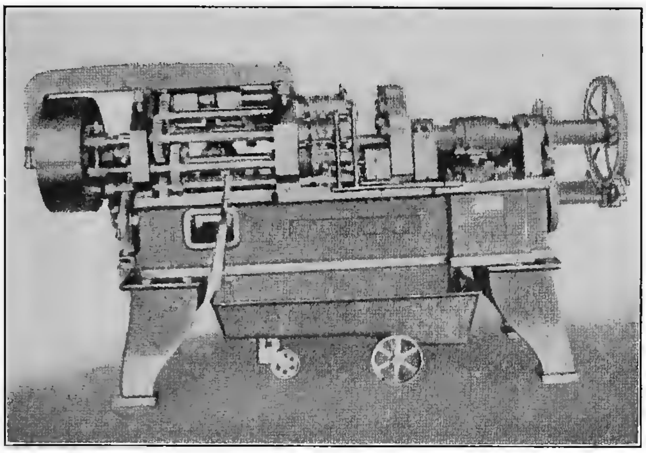


Fig. 1. Seven-Spindle Automatic

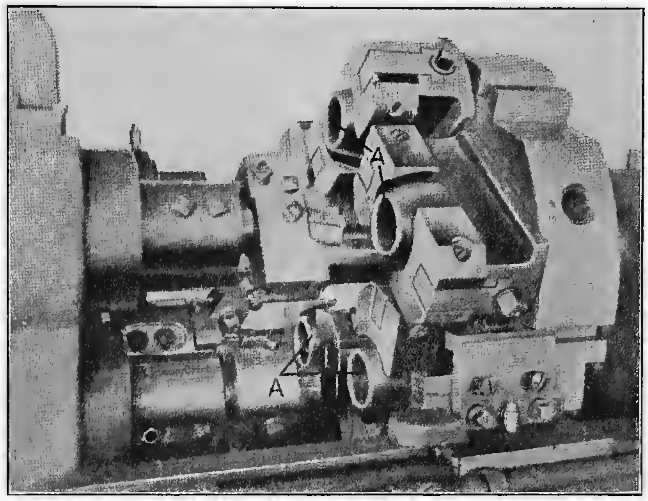


Fig. 7. View of Chuck Jaws for Shrapnel Heads

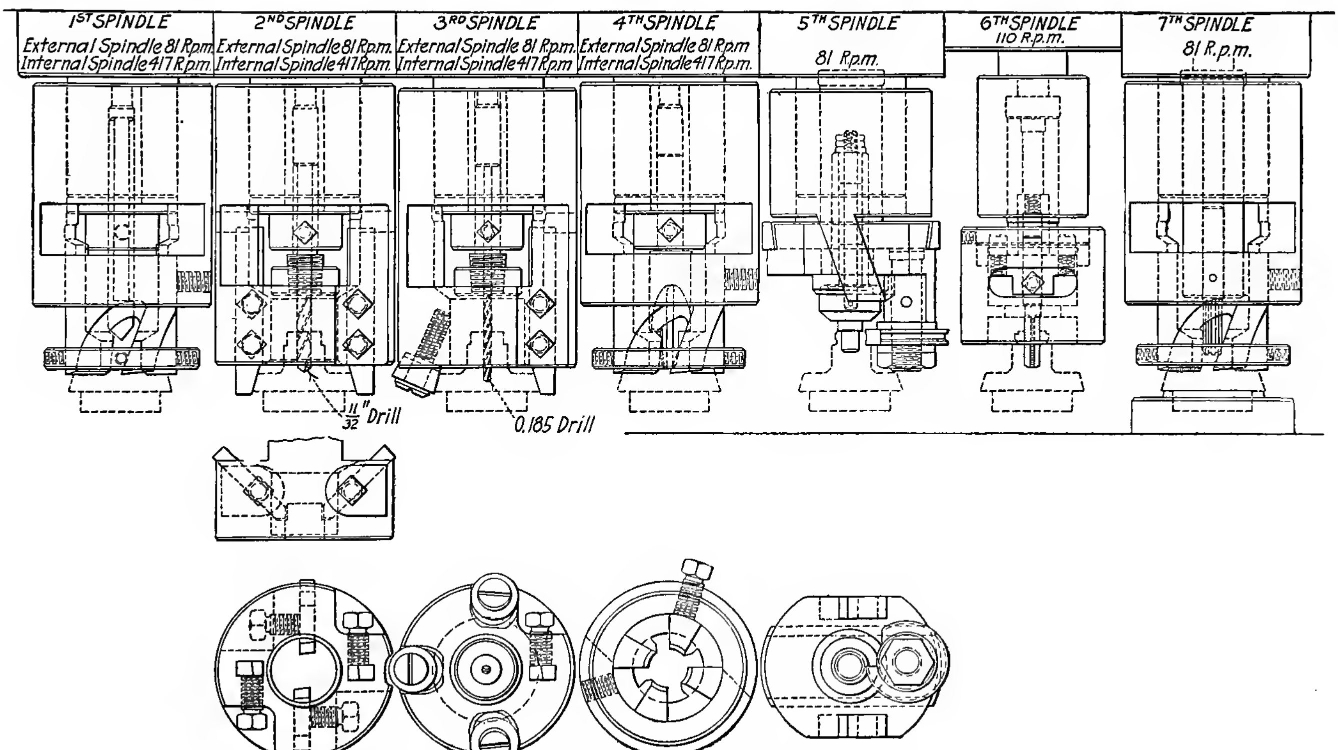
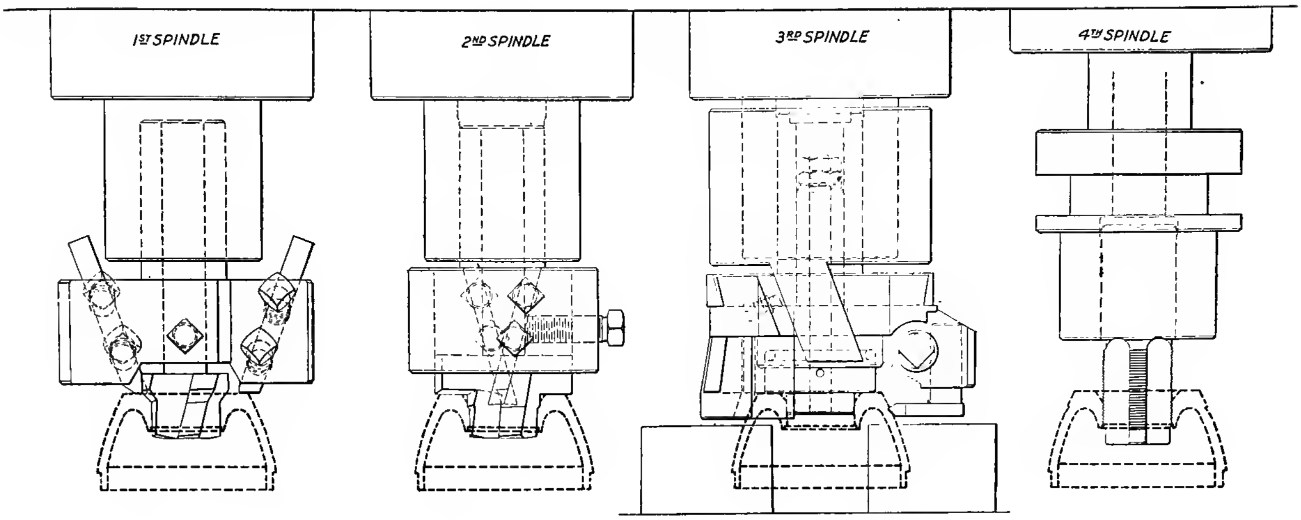


Fig. 4. Tooling for Machining Fuse Heads



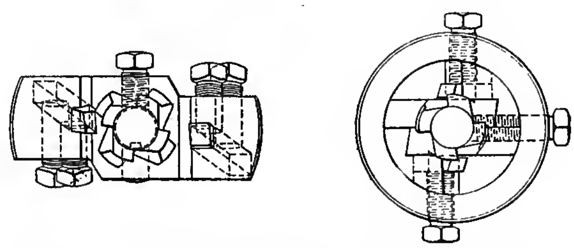


FIG. 6. FIRST SETTING FOR SHRAPNEL HEAD

The blanks, Fig. 2, are held on threaded draw-back collets. The end *A*, Fig. 3, is machined in the following order: The hub is drilled, counterbored, tapped, turned on two diameters, necked and threaded; and the flange is faced, grooved and turned. The finished pieces weigh 13 oz. The tools operate at a cutting speed of approximately 40 ft. per min. The production is 52 pieces per hour.

MACHINING SHRAPNEL HEADS

The tools—first setting—used for machining the 4.7-in. shrapnel head, Fig. 5, are shown in Fig. 6. The parts are made on a size No. 24 four-spindle chucking machine. These parts are cold-drawn steel stampings; the blanks weigh 42 oz. and are machined in two settings. The weight of the finished piece is 31 oz. The first setting is on the end *A*, Fig. 5, which is faced, chamfered, grooved, bored and tapped. For these operations the pieces are held in two-jaw chucks arranged with the stop plugs *A*, Fig. 7, which fit inside the forms of the pieces, thus locating them accurately. This method of locating is necessary, as the distance from the inside concave surface to the outside face must be accurate. The production is 62 pieces per hour.

For the second setting the pieces are held on threaded drawback arbors by the thread formed at the end *A*, Fig.

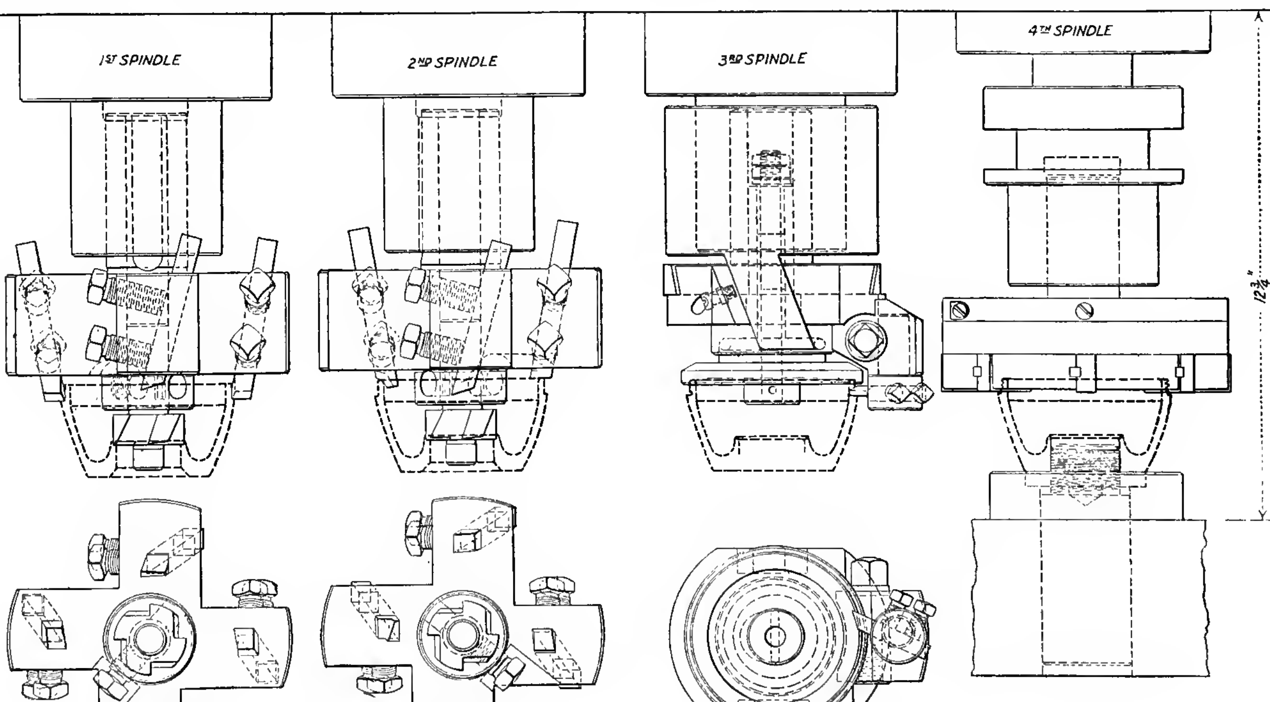


FIG. 8. SECOND SETTING FOR SHRAPNEL HEAD

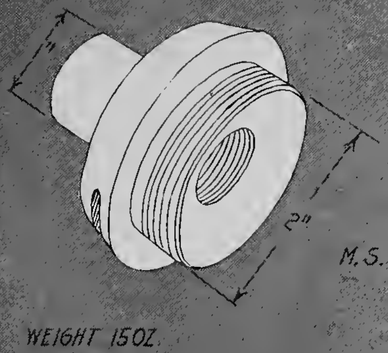


FIG. 2

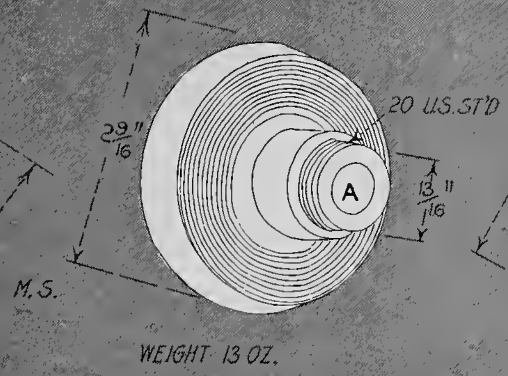


FIG. 3

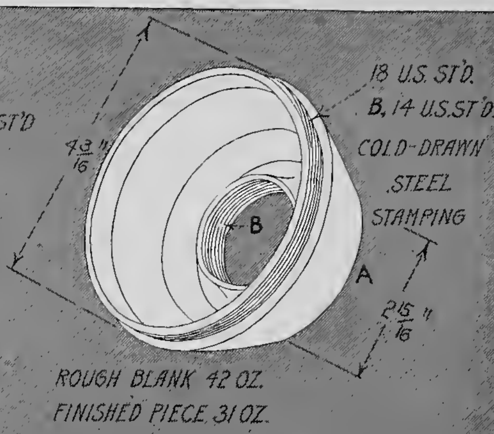


FIG. 5

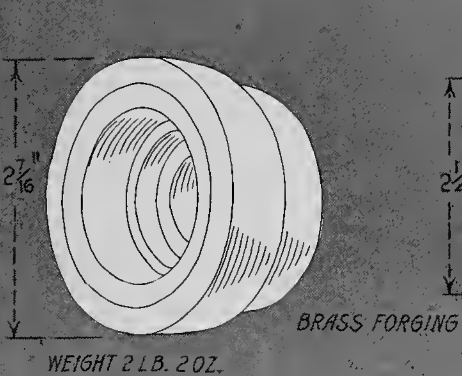


FIG. 11

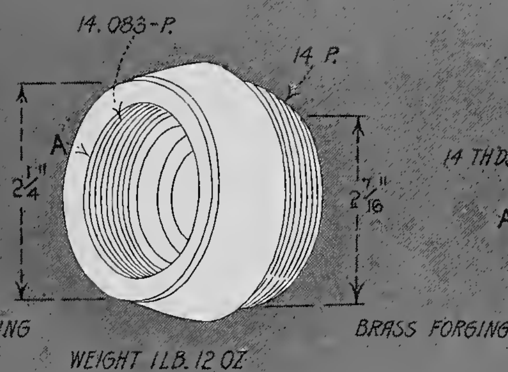


FIG. 12

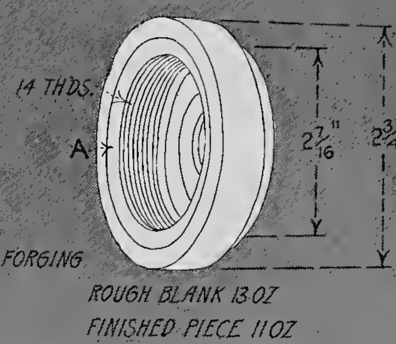


FIG. 13

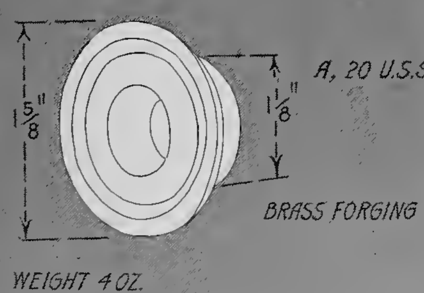


FIG. 16

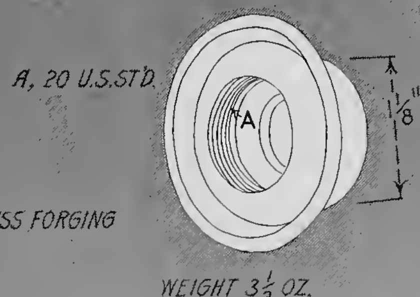


FIG. 17

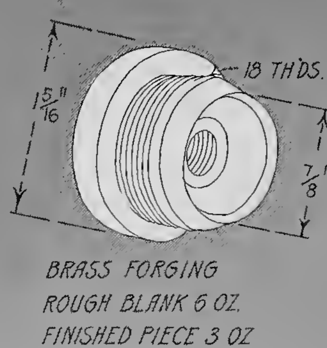


FIG. 19

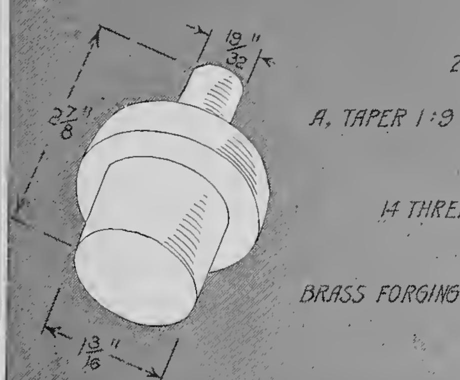


FIG. 21

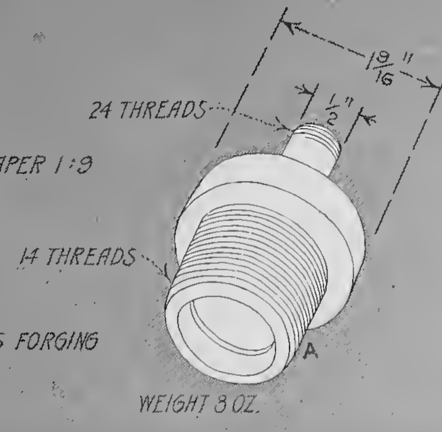


FIG. 22

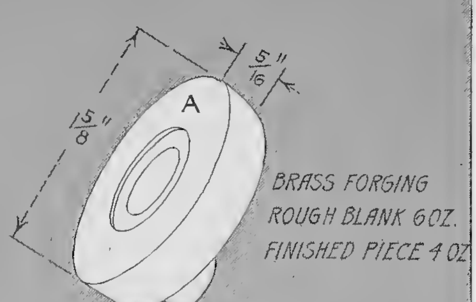


FIG. 25

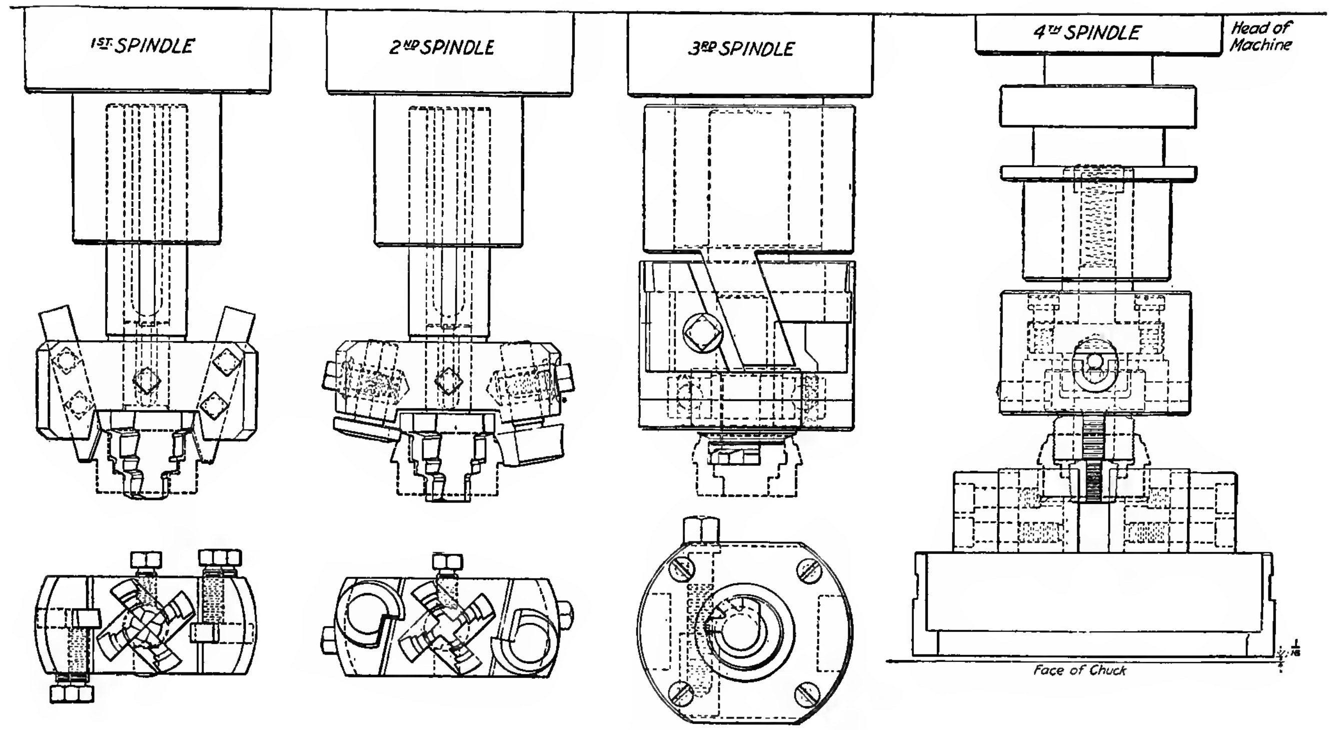
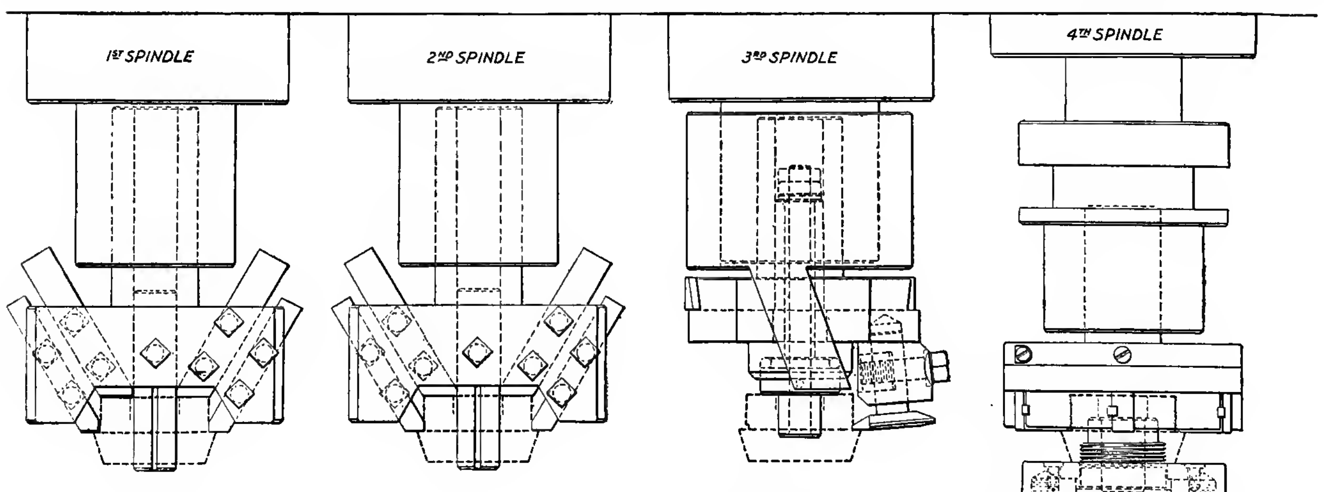


FIG. 9 FIRST SETTING FOR SHELL HEADS

5. The tools used on the large end are shown in Fig. 8. The operations are facing, chamfering, turning, necking, counterboring and threading. It will be noticed that the tools used for the first and second spindles are piloted in draw-back arbors to insure the machined surfaces being concentric. The production for this setting is 94 pieces per hour The cutting speed is approximately 120 ft. per min.

MACHINING SHELL HEADS

When machining the heads used on 18-lb. high-explosive shells, the tools shown in Figs. 9 and 10 are used.



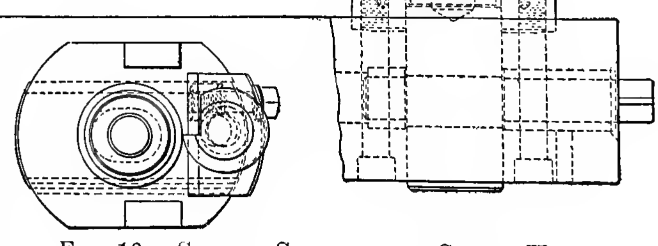


FIG. 10. SECOND SETTING FOR SHELL HEADS

The blanks, which are made as shown in Fig. 11, weigh 2 lb. 2 oz. each. They are machined to the form shown in Fig. 12, the weight of the finished piece being 1 lb. 12 oz. These parts are made from brass forgings and are machined in a size No. 24 four-spindle chucking machine. The first setting is for machining the ends *A*. The pieces are gripped in two-jaw chucks and the ends faced, formed three diameters, bored, recessed, and threaded two diameters. The production is 120 pieces per hour. The parts are then placed on threaded draw-back arbors which fit into the internal threads formed for the second setting. The machining operations consist of facing, turning, necking and threading. The production for this setting is also 120 pieces per hour. When machining this part the approximate speed of the tools is 80 ft. per minute.

MAKING SHRAPNEL SOCKETS

When machining the shrapnel sockets, Fig. 13, the tools shown on Figs. 14 and 15 are used. These parts, which

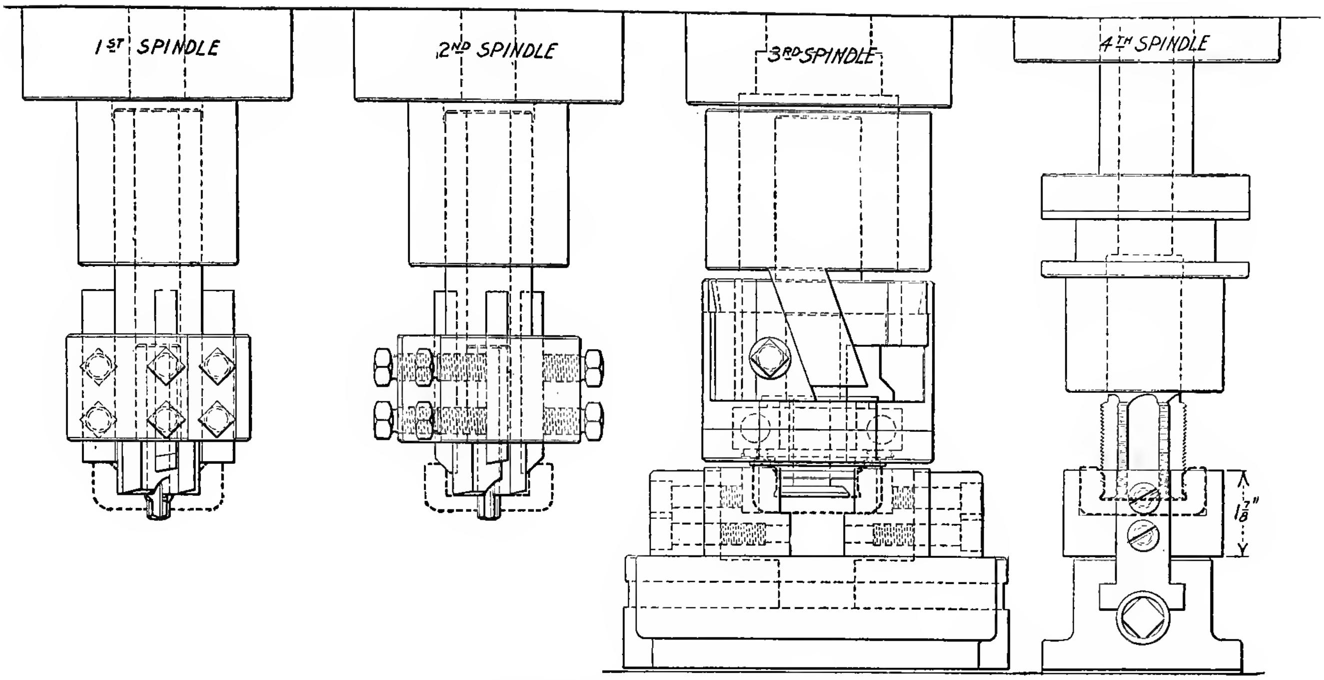


FIG. 14. FIRST SETTING ON SHRAPNEL BRASS SOCKETS

are made from solid brass forgings, are manufactured on a size No. 24 four-spindle machine. The rough blank weighs 13 oz. The first setting is on the end *A*, Fig. 13. The blank is solid, the parts being gripped in two-jaw chucks. The machining consists of facing, boring, recessing and tapping. The pieces are held on arbors located by the thread formed in the end. The production is 160 per hour.

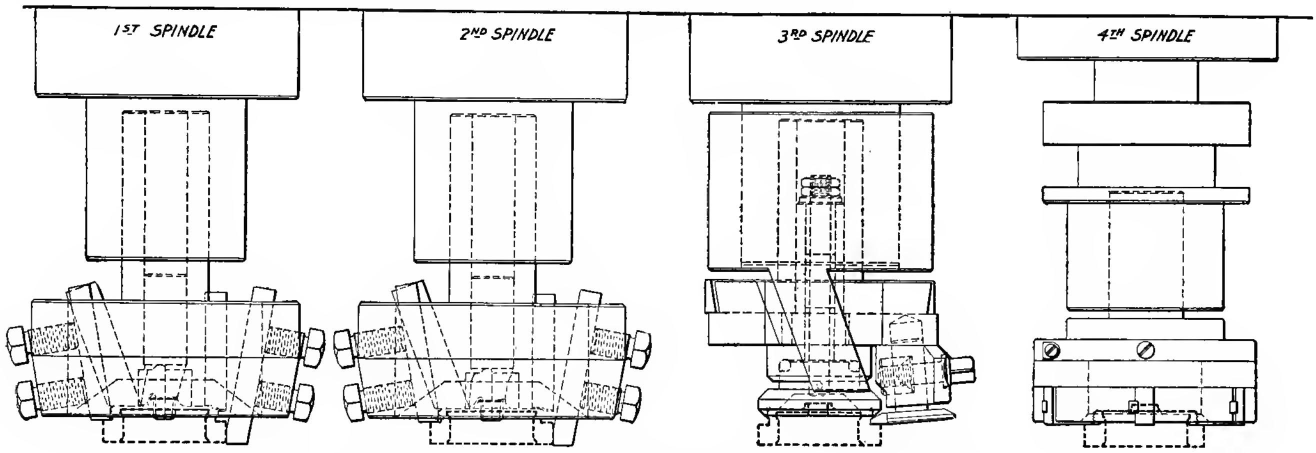


FIG. 15. SECOND SETTING ON SHRAPNEL BRASS SOCKETS

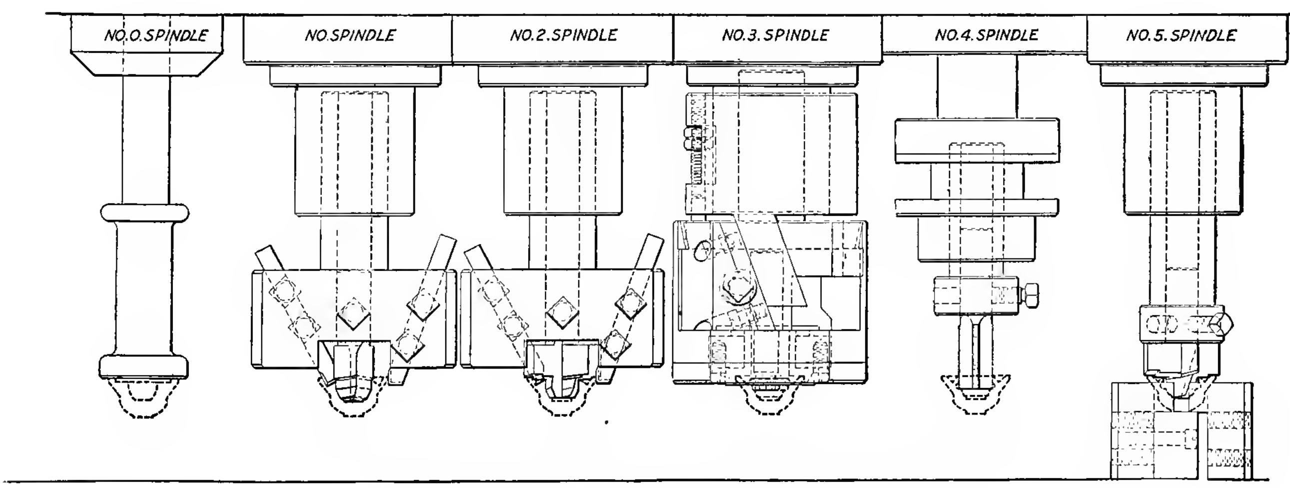


FIG. 18. TOOLING FOR MACHINING TIME-FUSE NOSES

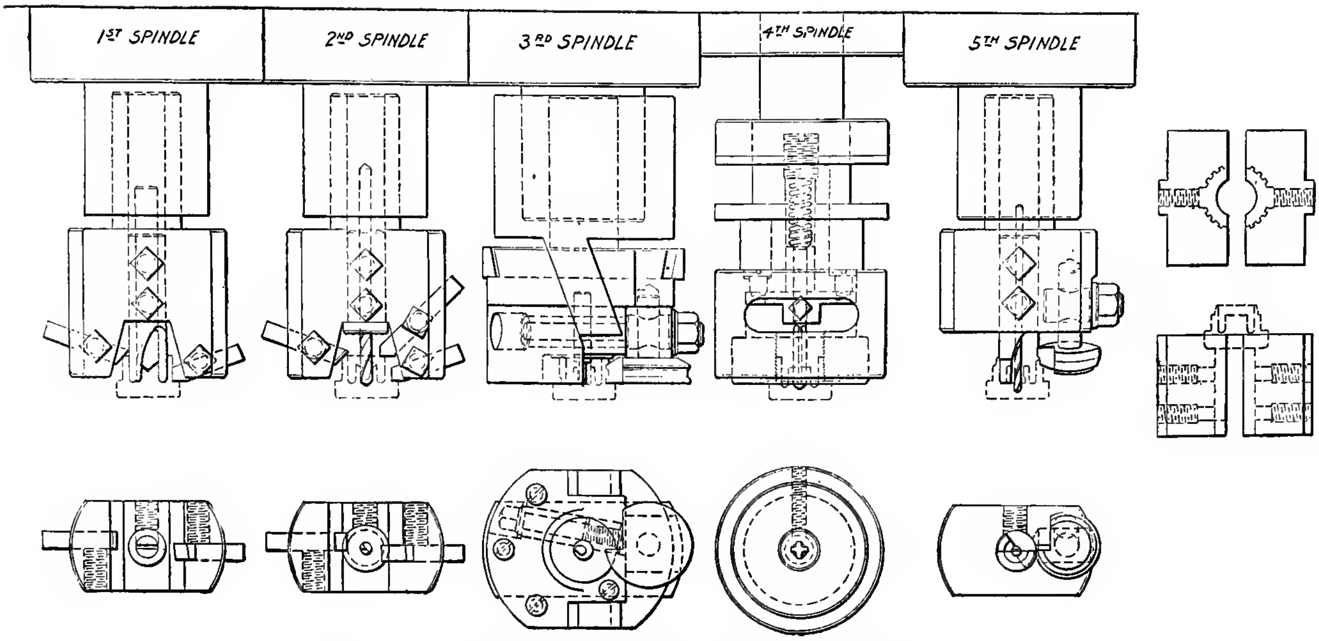


FIG. 20. TOOLING FOR MACHINING PROJECTILE PRIMING PLUG

In the second setting three diameters are turned, the end formed and necked and the outside threaded. The production for this setting is also 160 per hour.

The tools operate at a speed of 116 r.p.m. for both settings.

PRODUCING TIME-FUSE NOSES

The time-fuse nose pieces are made of brass forgings of the form shown in Fig. 16. These are then machined in one setting to the contour shown in Fig. 17 on a size No. 33 five-spindle machine, using the tools shown in Fig. 18. The rough blanks weigh 4 oz. each and the finished parts, 3½ oz. For these operations the forgings are held in two-jaw chucks. The inside is faced, formed, recessed and tapped. The production is 225 pieces per hr., the cutting speed being approximately 80 ft. per minute.

MAKING PROJECTILE PRIMING PLUG

The tools used for making the projectile priming plug, Fig. 19, are shown in Fig. 20. These are made from brass forgings on a size No. 33 five-spindle machine. They are solid and weigh 6 oz. each. The pieces are gripped in two-jaw chucks and the outside and inside operations are completely finished. The outside is turned, formed, necked and threaded. The inside is formed out with hollow mills, drilled, counterbored, necked back of tap and tapped, the tap and outside thread being of *different* pitch, but both threads being cut simultaneously by means of a specially designed combination tap and die head which allows the tool of steeper pitch to advance independently of the other.

Production on this piece is 180 per hour; weight of finished piece, 3 oz., and approximate cutting speed of tools, 100 ft. per minute.

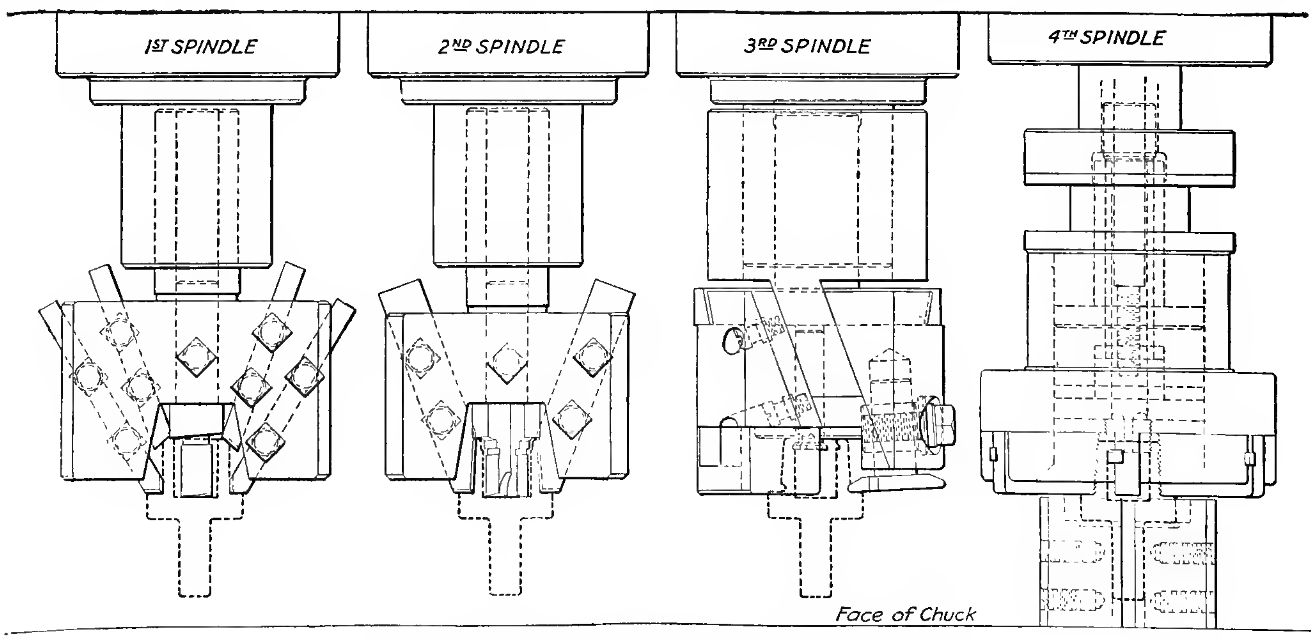
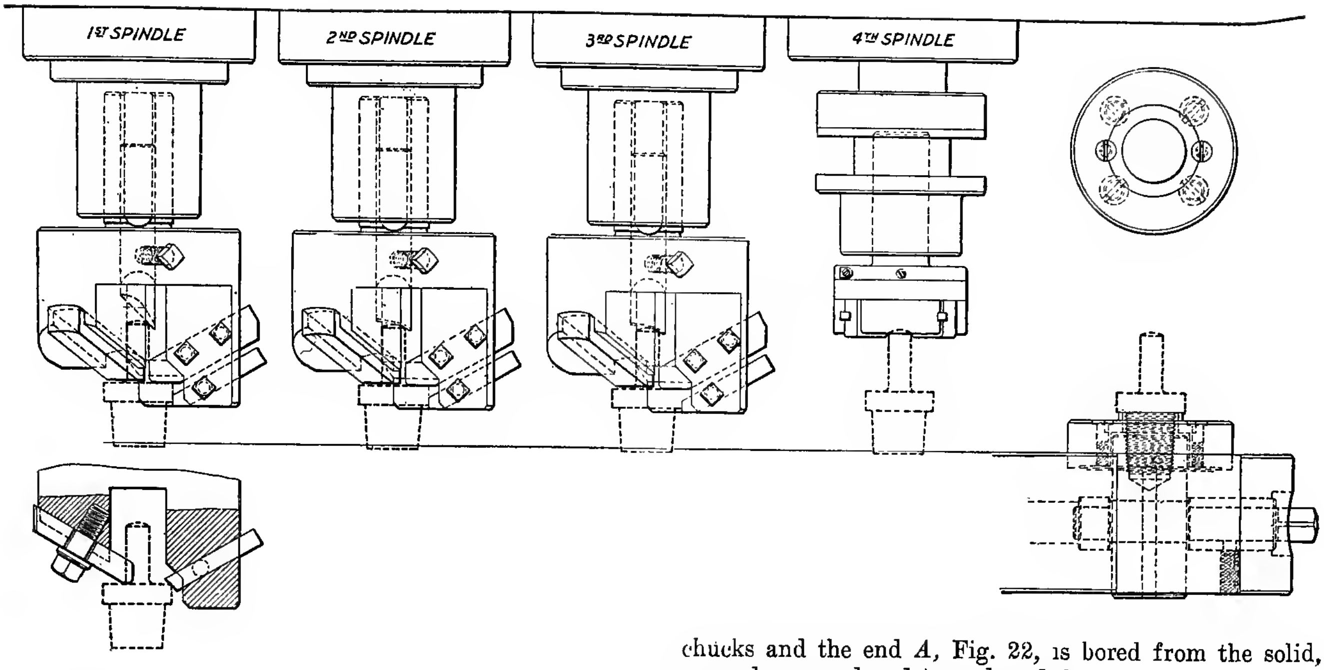


FIG. 23. FIRST SETTING ON TIME-FUSE BODIES



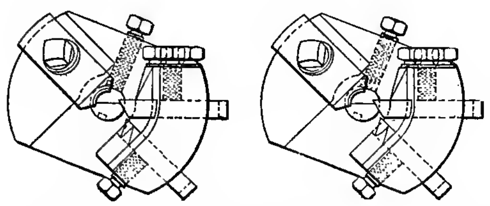
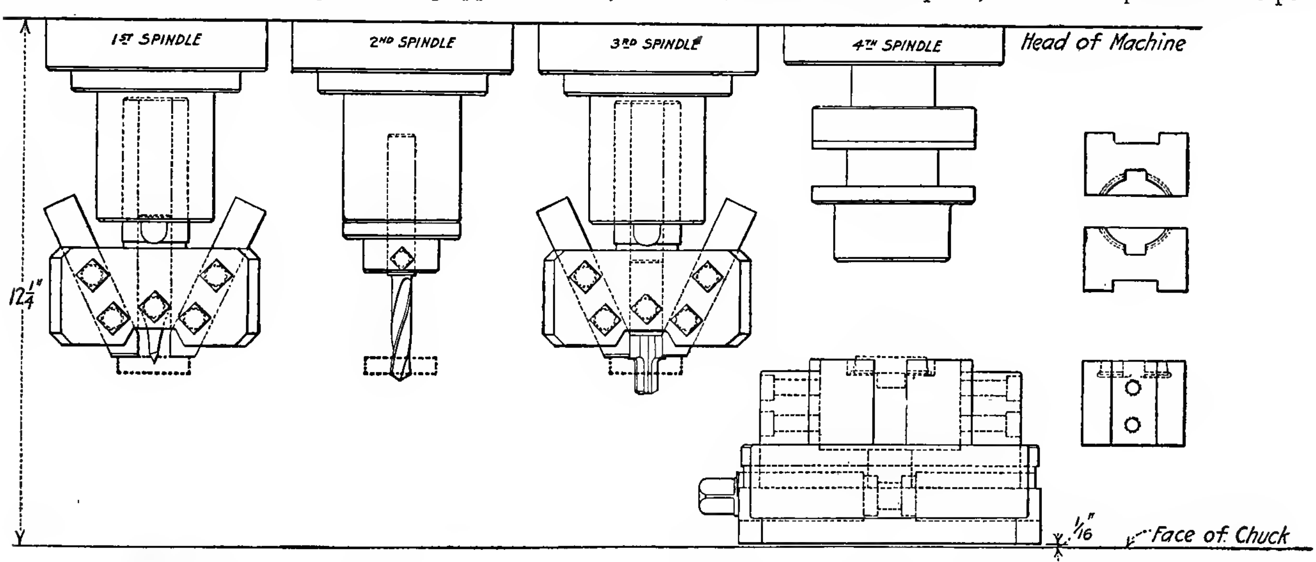


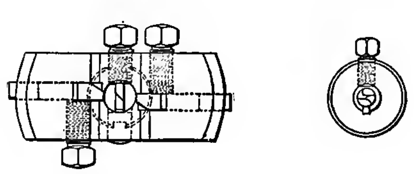
FIG. 24. SECOND SETTING ON TIME-FUSE BODIES

Time-fuse bodies, which are made from brass forgings, come to the machine in the form shown in Fig. 21. They weigh 13 oz. each. They are machined to the shape shown in Fig. 22, using for the two settings the tools shown in Figs. 23 and 24 on a size No. 23 four-spindle machine. For the first setting the parts are gripped in two-jaw chucks and the end *A*, Fig. 22, is bored from the solid, reamed, recessed and tapped, and the outside taper turned, faced and threaded. Although not so shown, this end is also internally threaded. The production for this setting is 55 pieces per hour. For the second setting the pieces are held in threaded draw-back collets which fit into the threads formed in the previous setting. The head and stem are turned and faced, and the stem is chamfered and threaded. The production is 120 per hour. The weight of the finished parts is 8 oz. each. For the machining operations on these parts, the tools operate at a cutting speed of approximately 80 ft. per minute.

MAKING TIME-FUSE RINGS

The time rings shown on Fig. 25 are made of brass forgings. The rough blanks for the pieces weigh 6 oz. each, and the finished parts, 4 oz. The operations are per-





formed in one setting on a size No. 23 four-spindle machine, using the tools shown on Fig. 26. The parts are gripped in two-jaw chucks and then the end *A*, Fig. 25, is faced, drilled and counterbored. The production is 240 per hour, and the cutting speed of the tools approximately 80 ft. per minute.

FIG. 26 TOOLING FOR MACHINING TIME-FUSE RINGS

Work of the Canadian Shell Committee*

BY JOHN H. VAN DEVENTER

SYNOPSIS—Two hundred Canadian machine shops are at work producing munitions of war. They are thoroughly organized into a great manufacturing unit in which each plant produces its specialty and depends upon other plants in the same way that one department does on another in a large factory. To avoid endless confusion, the various plants must be tied together so that their efforts will be directed most effectively toward the common end. This is the work of the shell committee, which controls the expenditure of $70,000,000.

The office of the Canadian Shell Committee is a busy place in these days. The space in front of the office railing in the ante-room reminds one of a crowded court room during general sessions, except for the mixture of cigar smoke and shoulder straps. The civilian element is well represented, however, in the persons of shop executives who are making, or who wish to make, war material.

HOW THE SHELL COMMITTEE CAME INTO EXISTENCE

At theoutbreak of the war, it became evident that one of the most serious problems to solve was that of an adequate supply of ammunition to continue war on such an unparalleled scale. The Canadian Minister of Militia, Major-General Hughes, called a meeting of prominent Canadian manufacturers, at which government ordnance experts explained the construction of the various shells that it was proposed to make. The question, Can it be done in Canada? which had been asked rather doubtfully by English officials, was answered in the affirmative by the assembled manufacturers.

Upon this decision, the shell committee was immediately appointed by the Minister of Militia, as a neucleus about which to arrange activities. It consists of Colonel Bertram,† chairman; Lieutenant-Colonel T. Cantley, of the Nova Scotia Steel Co.; George W. Watts, of the Canadian General Electric Co.; E. Carnegie, of the Electric Metals Co.; Brigadier-General T. Benson, master general of Ordnance; Lieutenant-Colonel C. Greville Harston, Canadian Institute of Arms and Ammunition; Lieutenant-Colonel F. D. Lafferty, superintendent of the Dominion Arsenal, and J. W. Borden, chief accountant of the Militia Department. Its technical ordnance advisor is David Carnegie, who formerly was chief engineer of Hadfields, England, the largest shell-manufacturing plant in Great Britain.

The Committee was organized on Sept. 2, 1914, and by the middle of the month following, the first shells were finished. They came from the shops of John Bertram Sons, Ltd., at Dundas, Ont. Mr. Carnegie took them with him to England to see if they would pass inspection. Since then there has been a steady stream of them finding its way across the ocean.

We have looked upon the United States as being the home of the excessively large industrial undertaking and the place where great schemes are carried out so rapidly that the process resembles slight-of-hand. But when it comes to a general average of number of plants, number of employees, geographical location and shortness of time available for organization, we must take our hats off to our Canadian neighbors and admit that they hold the record.

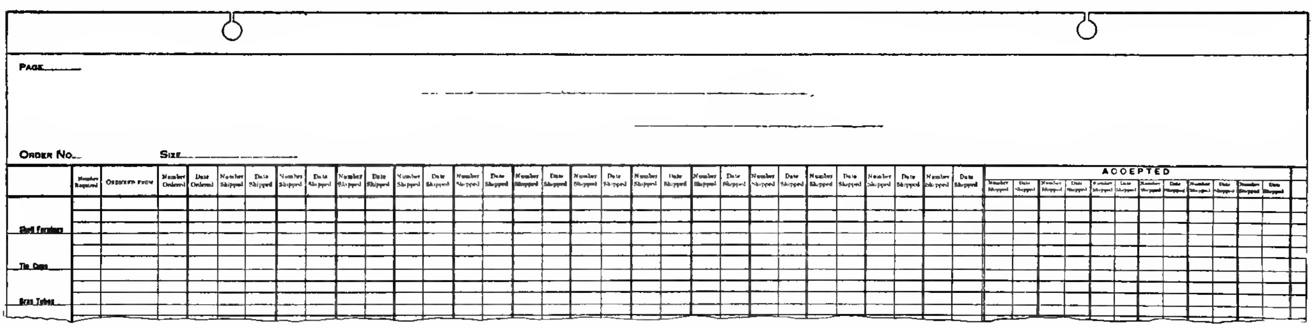


FIG. 1. FORM USED TO RECORD PARTS SHIPPED TO AN ASSEMBLING SHOP AND ACCEPTED COMPLETE SHELLS
The complete form (17x31 in.) provides for all parts

The thing has been done so quietly that but few have the least idea of its magnitude. Picture to yourself a combination of 200 shops, distributed from Nova Scotia to Vancouver; 40,000 employees and executives, and a working capital of $70,000,000. Imagine, if you can, these shops divided as to activities so that certain ones produce certain component parts in the proper quantities to feed those plants which have been assigned the finishing operations. Try to imagine the detail and energy necessary simply to control the handling of material betewen these various plants. Imagine the task of inspecting the product of each feeder shop before it is passed along to the next one. Imagine the task of accounting and recording all the individual plant earnings and operations, and of auditing them for payment. And then, if you have any imagination left, try to think of all this being

*An interview with its active head, Colonel Bertram.

†By the time that this article goes to press it will be very likely that the official announcement will have been published, gazetting Colonel Bertram as General. He has been referred to under the former title in this article because his friends in the machine-tool industry will be more familiar with it and because, at this writing, the official announcement has not been made.

put in working shape, and organized within the space of six months!

People Who Thrive on Hard Work

The Colonel sat behind a desk surrounded by evidences of activity. Shell samples in all stages of completion decorated the room. Brass cartridge cases and timing fuses were in evidence. Even the desk lighting fixtures were made of discarded shells—good ones being in too great demand for other purposes. The well-blackened meerschaum pipe that occupied a corner of the desk presented a strong contrast to all of these warlike implements. One might have expected to see signs of strain due to these strenuous demands and long hours of work, but none were in evidence. I expect that the pipe has "done its bit" to help in this respect, and if so, it deserves a place in Canadian history.

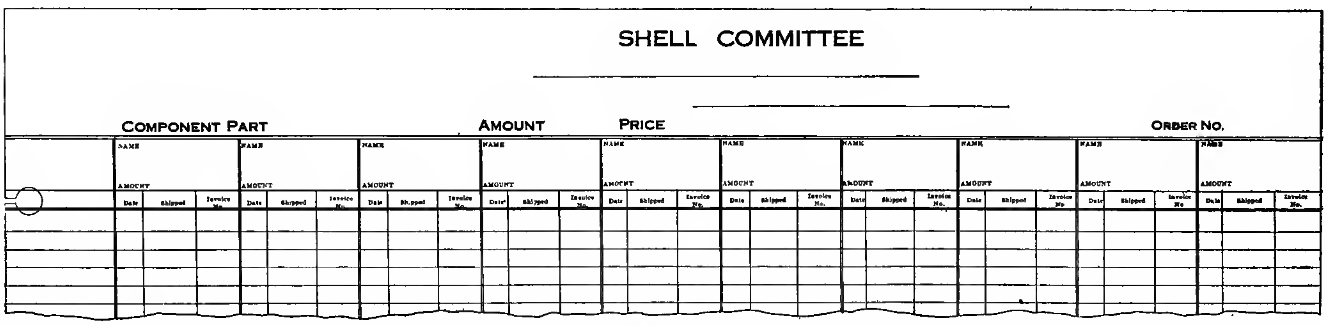
"It is all due to the remarkable spirit coöperation," said Col. Bertram, modestly, in reply to my inquiry of how such results had been possible. "Plant managers who had been in the habit of getting to the office at 10 in the morning are out in the shop in their shirt sleeves at seven. They are working harder than they ever have before in their lives."

How the Committee Attacked the Shell Problem

"In attacking this problem," said the Colonel, "we took one shell at a time and divided it into its component parts. There were ten of these in the case of the 18-lb. shrapnel. We had to make sure of a supply of forgings, disks, powder cups, powder tubes, lead balls, fuse sockets, fuse plugs, grub-screws, rosin and wooden shipping cases before we could arrange for the final operations of finishing, filling and assembling. Then too, we had to arrange for the inspection of all of these component parts—a task quite aside from the government inspection, which has to do only with the finished shell. We employ over 200 inspectors at this work, and they are all directed and managed from this office."

I ventured that in subletting these various parts to different shops, it must have been difficult to arrive at an equitable price schedule.

"That was done very simply," replied the Colonel, with a laugh. "We had no time to make involved and lengthy estimates, so we advertised for bids on the various parts. When they were all in, we took all of the bids on a certain part, added them up and struck an average. We let the manufacturers do the estimating, and the result has been quite satisfactory."


SHELL COMMITTEE

COMPONENT PART AMOUNT PRICE ORDER NO.

	NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT			NAME / AMOUNT		
	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.	Date	Shipped	Invoice No.

Fig. 2. Form Used to Record the State of Shipments of Each Component Part on Various Contracts

"This spirit and the necessities of the case have resulted in some rather remarkable work," continued the Colonel. "Machines are being used for purposes of which their designers and builders never dreamed. Just examine this 3.3 in. cartridge case."

I looked at a very perfect specimen of deep-drawing and heading.

That work was done on bulldozers and frog planers. It was difficult to get deliveries on cartridge-case machinery. And it was quite necessary to get some of these coming along before proper machinery could be delivered and installed. So we turned to the railroad shops. Through a happy thought we tried drawing the cases on bulldozers. It worked to perfection, and the brass shells made by this process came out within a thickness limit of 0.001 in., well within the requirements inasmuch the customary allowance is 0.004.*

Through all of my visits to Canadian shops, I have been impressed with the fact that improvised equipment with brains and energy behind it can be made to accomplish remarkable results. The production of excellent cartridge cases on such unlikely machines is an additional proof that we do not begin to know the limits of our common mechanical equipment.

*This work will be described in a forthcoming series entitled "The Angus Shops in War Time."

As a matter of fact, where a large number of independent shops are involved, this is as accurate a way as could be imagined to arrive at a fair price. Some shops, of course, are making more profit than others, but, as Col. Bertram expressed it, "The different shops are jealous only of one another's output—not earnings."

A walk through the main office of the committee headquarters, to inspect the routine of activities in detail revealed a system of records worthy of note for simplicity and effectiveness. The tracing of orders and recording of partial shipments are cared for on two sheets designed for the purpose. The first, shown in Fig. 1, records shipments of component parts made to an assembling plant. It indicates not only the supply of parts, but also the output of accepted shells, space being provided for this at the right-hand side. By showing both of these incoming and outgoing quantities, it also indicates at once any shortage of component parts or their undue piling up, should this occur. Entries are made upon this sheet from the shipping bills of the delivering shops, subject, of course, to check for both quantity and quality by the committee's inspectors.

The second sheet is intended to record the state of orders of individual component parts and has nothing to do with the assembling shops. It is from this record sheet that invoices are passed for payment.

Shortages are cared for very simply. To avoid confusion in the records, and changes in contracts and billing, all shortages are made up so that the exact number specified is eventually delivered on each order. For example, on an order for 5000 grub-screws, where 32 of them were short, the missing 32 were sent along by parcel post.

The Colonel had one big advantage to start with, due to his long experience at machine-tool building and his acquaintance with the shops of Canada. As most of you know, he is president of John Bertram Sons, Ltd.

I remarked that his plant must be overwhelmed with orders for machine tools, thinking of the demand for these that we have felt in our own country. "We haven't time to make machine tools, we are too busy turning out shells," was the reply. Evidently patriotism begins at home in this case.

"There is one big thing that I want to impress upon you," he said earnestly. "It is so big that I don't believe that anyone of us as yet fully grasps what it means. As you travel about from shop to shop, you will notice how quickly the best methods from one plant are adopted in another. The result of this has been a raising of the average all along the line until the whole process of shell-making in the majority of shops today may be said to consist of a combination of 'best ways.' It is due to the coöperation that is manifested everywhere—to the absolute lack of petty jealousy and to the freedom with which ideas are interchanged."

There is a big truth here for us to take home and think over. Patriotism, of course, is the underlying cause of the result. The intermediate and more direct cause, however, is the breaking down of secretiveness and the free exchange of ideas. The result has been so remarkable in the manufacture of ammunition that I am sure Canada will apply it to its peaceful industries after the war has ended. If she does, it will not be long before her material losses are offset by a higher industrial efficiency.

But at what a cost! Those of us who have seen the khaki-clad flower of Canadian manhood, with blankets and boots slung over shoulders, gently freeing themselves from the farewell embraces of little arms; those of us who have seen the look in the eyes of the women who must stay behind and wait; those of us who have seen these things have had a vision of the real price that must be paid and can but wish our sister country all the material compensation possible, knowing that, at the best, it will be sadly insufficient in the present generation.

The Effect of War on Machine Tools

The effects of the European war are being discussed from all sorts of viewpoints. We are told that the biological effect is deplorable—the next generation in the warring countries must be bred from the weaklings who were unfit for military service. We are told that the financial effect will be disastrous—the next generation must work with redoubled efforts to repair the waste now going on. We are told that the industrial effect will be revolutionary, due to the destruction of some industrial centers and the establishment of others, and to the flow of labor in the refugees of the present and in the emigrants who will leave after the war is over.

But all these views are partly speculative and, to that extent, valueless. We can discuss with more profit the effect upon machine tools, for this is a war of machinery.

War necessity has no restraint. Twenty-four hours a day and seven days a week is the working time of machine tools engaged in producing war materials. There is no time for rest, no time for bearings to get cold. Many machinery builders shrink from overtime and night work because of the certain destructive effect upon their equipment. Wear, losses, and breakage are always greater in proportion under overtime and rush-work stress than under regular conditions. Thus, when from necessity a plant must adopt night work and keep machines rushing all the time under the greatest possible pressure for production, what will be the result? It is reasonable to believe that a year of such driving will take more out of machinery-building equipment than five years of ordinary usage.

The present demands upon the machinery-building plants of England, France, Germany and Russia are tremendous. The Allies are buying machine tools all over the United States. Shipments even thus far have been enormous when compared with the average of the preceding years. The German Government has ordered machinists from the army to the shops, for the machine-tool builders could not meet the government requirements without more workmen. The British Government has withdrawn skilled recruits and sent them back to machine and bench. Immediately after war was declared France commandeered machine tools from small machine shops, job shops, and private owners, assembling these in large groups and establishing a factory system for producing ammunition. Russia is beginning to take large numbers of machine tools by the Pacific route.

These few facts give a hint of the strain and pressure upon the machinery-building capacity of the warring nations. The demand includes not only the production of rifles, field guns, ammunition, aëroplanes, automobiles, war vessels, and rolling stock—all subject to destruction in time of war—but also machinery repairs and replacements to maintain the living conditions of the noncombatants. Machine tools and small tools must be wearing out faster under this stress than ever before in the history of the world.

A striking comment concerning all this comes from a German correspondent. He writes:

You cannot possibly have an idea of the enormous boom in machine tools in this country [Germany]. For instance, a turret lathe or engine lathe is at present not to be had for love or money. Lathes four and five years old are fetching more money than when they were new. A multiple-spindle automatic has become a valuable property and the man who owns four or six is sure to make a fortune inside of a year. This is no tale from fairyland, but absolute fact.

If Americans are alert and quick in adjusting themselves to the new conditions, they will benefit. But this, however, is not exactly the point I want to impress you with. The majority of machine tools in this country are at present put to such hard use night and day that they will be fit for the scrap heap before the war is over. The same can be said of the motor cars and quite a number of other kinds of machines. I cannot go into detail, but I assure you that at the end of the war a quite unparalleled situation will arise for the machine-tool industry.

The Angus Shops in Wartime

By John H. Van Deventer

SYNOPSIS—A description of some remarkable mechanical achievements at the eastern shops of the Canadian-Pacific begins with this number. What has been done at this plant proves conclusively that energy and incentive can overturn precedents set by customary practice. In this article, which will be followed by others describing the work in detail, the wartime activities at Angus are outlined. It tells, also, how a 33,000-lb. hay-baling press was machined, erected and delivered in eleven days.

If an eye specialist who had for years devoted his attention to the organ of sight should under the spur of necessity remove one's appendix with the aid of a cork-screw and hacksaw, it would be considered rather a feat of adaptation. But on close analysis, one can hardly say that this would be more remarkable than the adaptations of skill and machinery which have been made at Angus since the beginning of the war.

Fig. 1. A Station-Type Indenting Press Built at Angus

Angus is the home of the eastern shops of the Canadian-Pacific Railroad. Normally, 8000 men are busy there building and repairing locomotives, freight and passenger cars, and almost every other species of movable railway equipment. It is one of the largest railway shops, and few, if any, are more completely fitted to turn out rolling stock and its appurtenances. Also, as is generally the case in railroad shops and which make the present transformation more remarkable, most of those who work there are distinctly locomotive and car-shop men. They have served their time at this kind of work. Like the eye specialist, they have been at it for years and have done little of anything else.

A Complete Transformation

Today, Angus is an arsenal in full working order. It bristles with war activities. Mechanics have forgotten that there are such things as motion blocks or cross-head pins and are turning out shrapnel shells. Car builders who have been accustomed to the generous fit allowances applied to freight-car trucks are drawing brass cartridge-cases to the thousandth part of an inch. Precedent and past practice have been overthrown in the face of the mandate—*"Do it with what you've got."*

In the manufacture of war material one finds certain demands which are staple and which lead to a standard output and others which are spasmodic and consist of special constructions. Angus has had its share of both. It is one of the few Canadian shops, for example, which is making both the shrapnel shell and the brass cartridge-case for it. In addition to these staple products, to which three large shop buildings are devoted, some exceptionally fine work has been done at very short notice in the locomotive shops.

Making Forging Presses for the Nova Scotia Steel Company

Take the shell-forging presses for the Nova Scotia Steel Co. for example. Before completing shrapnel shells, one must have the forgings, and to make these, powerful presses are required; their stroke is unusually long, and they must exert a pressure of some 300 tons. The weight of a press of this type is over 62,000 lb., and its size combined with peculiarities of design would seem to make it impossible to get such equipment in a hurry.

Alive to the necessities of the case, Angus accepted the order for the first press of this kind made in Canada. Twenty days later, the first machine was shipped. In the interim they had designed and built the patterns, cast and machined the parts, and assembled and tested the completed press. Moreover, as you will see in a subsequent article, much of the work was beyond the range of the available machine equipment.

Hydraulic Presses for Cartridge-Case Work

The same necessity for quick delivery led the Canadian-Pacific to build its own presses for cartridge-case indenting and heading, as well as the accumulators with which these presses are operated. Presses weighing 500 and 800 tons with rotary-station dial-feed tables are a little out of the regular line of work for a locomotive shop;

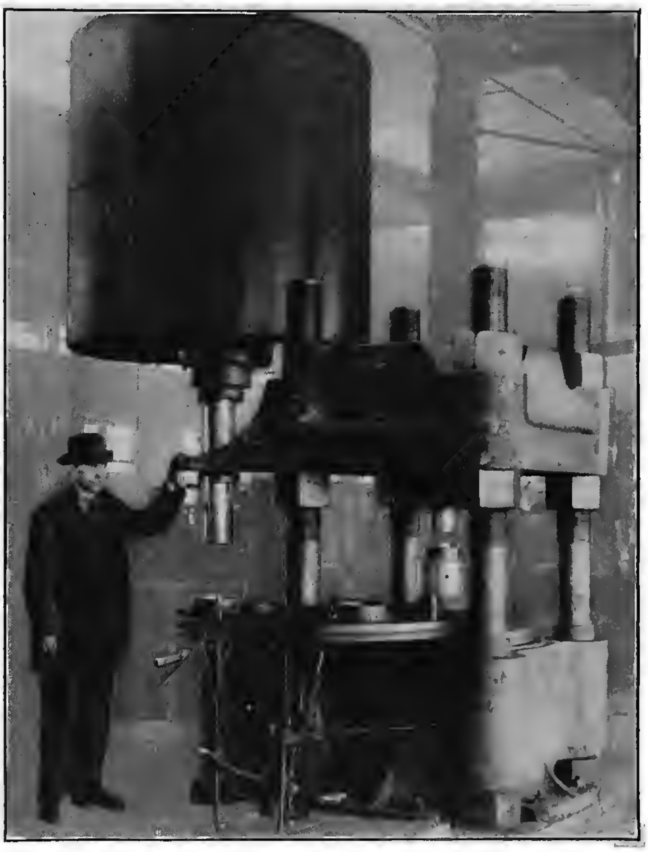


Fig. 2. Angus-Built Cartridge-Heading Presses and Accumulators to Operate Them

in fact, somewhat beyond the capacity of the machine tools that are found there. This did not stand in the way of producing them at Angus, however, and their action has been so satisfactory that a number of them have been supplied to other concerns in Canada.

Making a Hay-Baling Press in a Hurry

An exceptional case of quick delivery is that of the first hay-baling press manufactured at this plant, which is shown in Figs. 3, 4 and 5. The first intimation that the shops were to build such machines was received Wednesday, Aug. 12, 1914. The first machine was running in the shop on Saturday, Aug. 22, 1914, and was delivered at the wharf the next day. By Tuesday noon, Aug. 25, it was pressing hay. The second machine was delivered Tuesday, Aug. 25; the third and fourth on Wednesday, Aug. 26, and the fifth on Thursday, Aug. 27, making a total of 15 days for the complete shipment of all five machines.

The fact that the machine itself weighs 33,800 lb. and is, to say the least, a little complicated, makes this achievement one worthy of noting. No drawings were available for the machine, patterns being made from a model and the design, improved in many respects over the original,

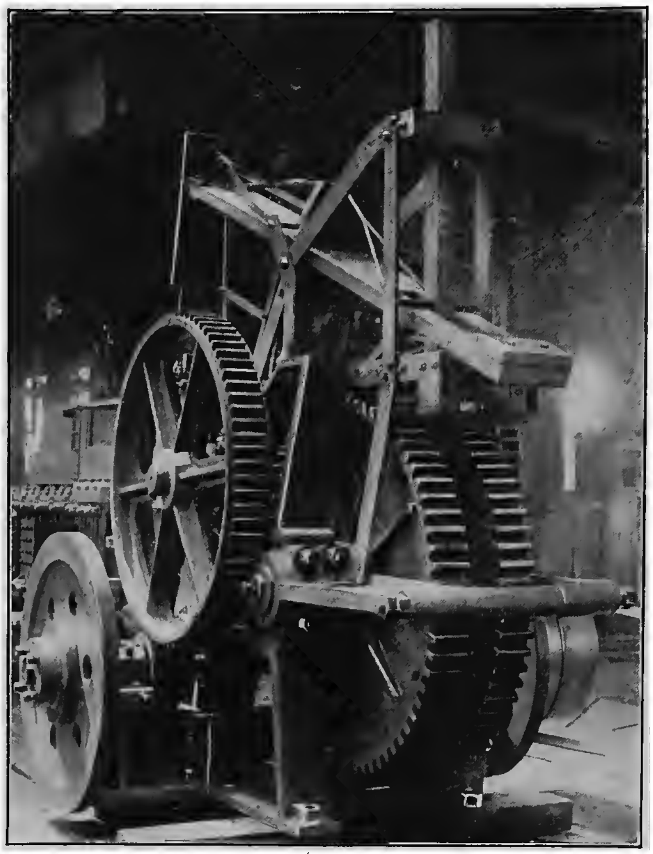


Fig. 4. Rear View of the Hay-Baling Press

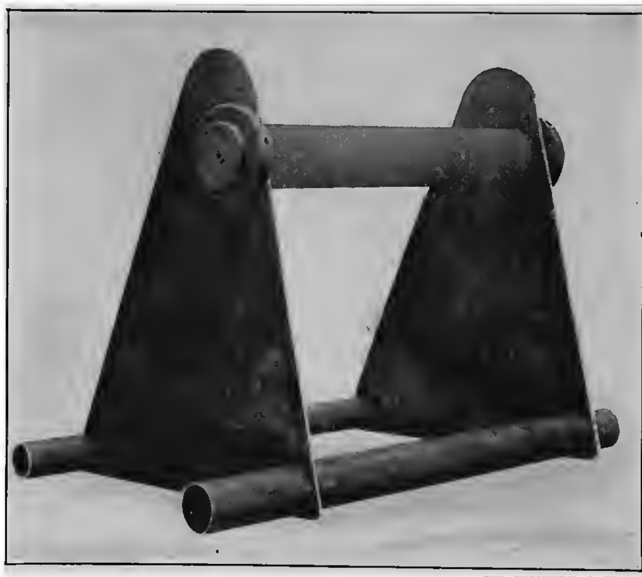


Fig. 6. Jig Used for Babbitting Hay-Baling Frames

proceeding simultaneously with the building of the first machine.

Action of the Hay-Baling Press

The action of this hay-baling press is of interest, as it gives an idea of the nature of the machine built in such remarkably quick time. Loose hay is shoveled, or forked, into an opening at *B*, Fig. 5. At regular intervals, determined by a cam device, the board C descends as indicated by the dotted line, forcing the loose hay into the space L just ahead of the ram G. This ram then moves forward, compressing the hay and clearing the chamber L at each stroke. When sufficient hay has been compressed to form a bale, a lever M is tripped by the machine operator. This drops a cast-iron block B in front of the plunger. There are a number of these blocks, and their function is to divide the hay into bales and to permit of its being wired, each block containing wiring grooves E through which the soft iron wire is passed. The wiring operation is done by hand when the bales reach the opening H.

The bales then pass through the space I, which is inclosed with steel slats that furnish sufficient resistance to the passage of the bales to enable their compression to be accomplished by the thrust of the plunger—a thrust, by the way, estimated at 35 tons.

While the hay-baling press may be called a crude machine, the fact that the first one was completed in a strange shop in 11 days indicates a far from crude shop organization, especially when it is remembered that drawings were not available to work from.

Jigs and Fixtures on Hurry-Up Work

It might be thought that on rush work of this kind no time would be taken for jigs or fixtures. In this case the contrary was true. In Fig. 6 is shown a babbitting jig used for the main frame, which carries the gear and flywheel at the rear end of the machine. This frame weighs some 5½ tons, and as a result of using the jig, one frame is quite interchangeable with another—a fact that had significance shortly after the first machine was set in operation, as will be apparent a little later.

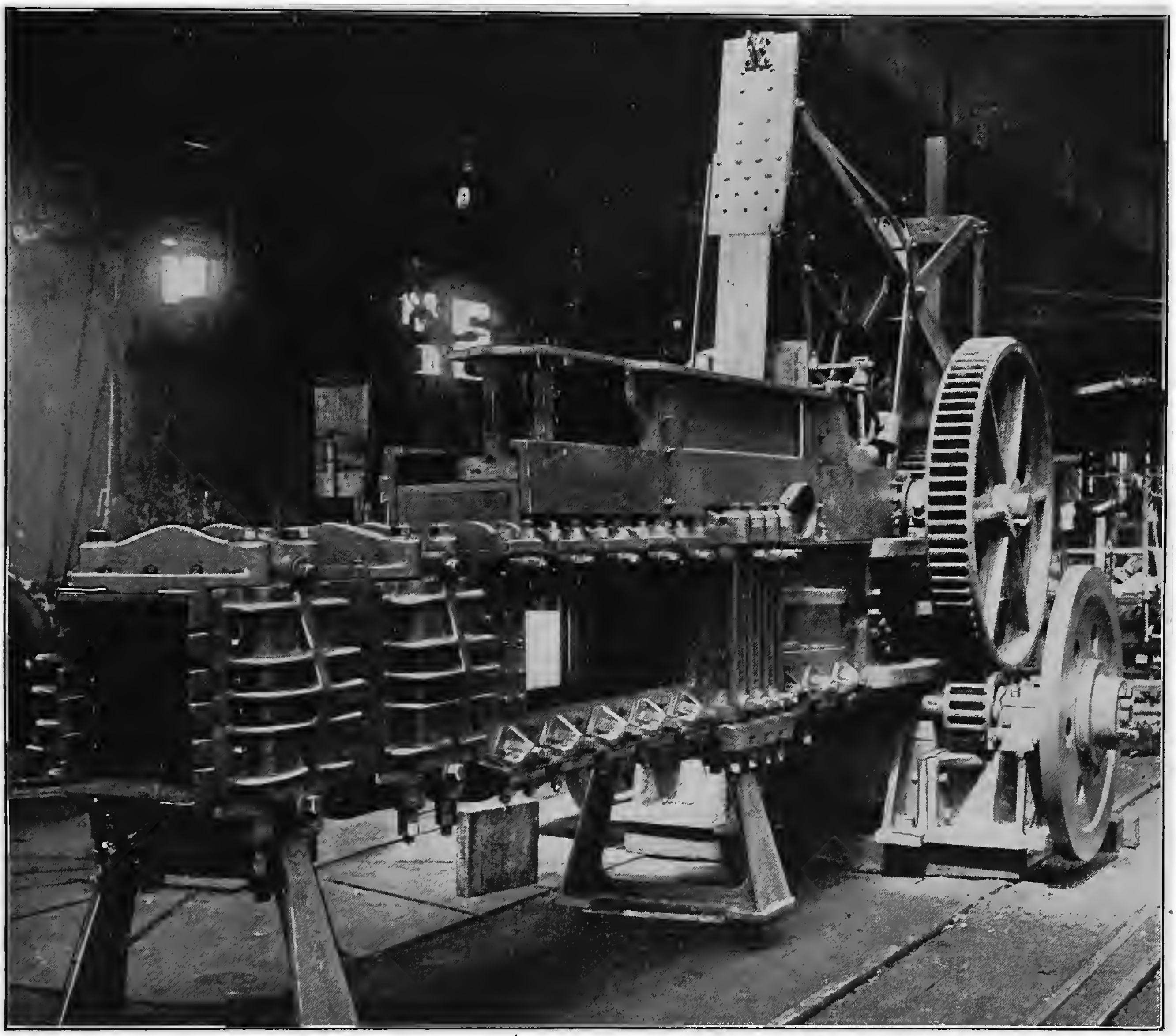


Fig. 3. A Machine that Was Built and Shipped in Eleven Days, Including Patterns

These hay-baling presses were installed on one of the waterside piers at Montreal and were kept busy baling much-needed hay, which was shipped to France. The capacity of one machine is 60 tons in 10 hours, and just at the time when all of the machines were urgently needed, the main frame of one of them broke, due to an undiscovered defect. Had it not been for the use of jigs in building these machines, this would have meant a serious setback and probably a week's delay. As it was, the new frame was in place and the machine running again within 24 hours. The new frame was very simply installed by jacking the body of the machine up sufficiently to clear the floor of the dray on which the casting was sent over, and then backing the latter up until the bolt holes came line in line.

It is interesting to note the effect of hay upon the steel strips which form the bale passage of the machine. Deep grooves are scored into the metal of these strips through friction of the wisps of hay, this taking place most frequently when the machine has been heated by friction, at which time the hay appears to deposit a sticky substance which helps to cause the scoring.

THE MAN BEHIND THESE ACTIVITIES

H. H. Vaughn is the man to whom credit must be given for setting these various activities in motion. Early in the war his energies were applied to the new demands,

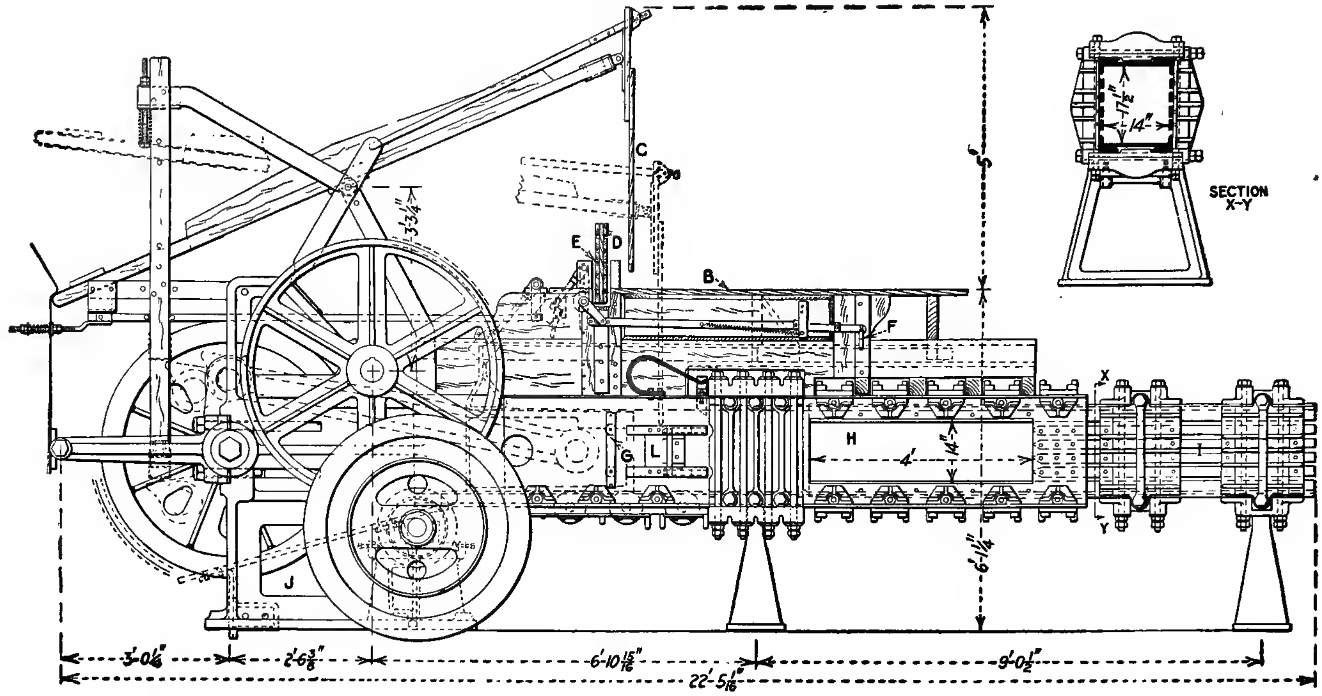


FIG. 5. DETAILS OF THE HAY-BALING PRESS

FIG. 7. GENERAL VIEW OF THE CARTRIDGE-CASE PLANT

H. H. VAUGHN

this finally resulting in his giving up his regular work in order to have more time for them. It was through his efforts that the red-tape ordinarily necessary in a large railway plant was lifted sufficiently to secure quick results. He must also be credited with a broad conception of the ultimate possibilities of machines and men, considering the remarkable adaptations of both that have been made at this plant.

The versatility of railway mechanics and car builders may have helped. They are a widely traveled class as a rule, as evidenced by the inspector who told the story of the man who lost a Pullman car. This inspector had learned his trade in England, worked at car building at the De Beers mines in South Africa, landed over in the States with the Pullman Co., and finally hooked up with the Canadian-Pacific in time to help them make cartridge cases for his native country. He told of a Yankee car-erector who had been sent to Africa with a shipment of Pullman cars made for the De Beers Co. at the time he worked there.

THE LOST PULLMAN CARS

This Yankee erecting man was a very capable fellow in his way when sober, which, unfortunately, was but a small part of the time. He took a decided fancy to the inspector, who worked with him during his stay in Africa. Some years later, the inspector came to the States and, landing at the Pullman plant, happened to ask for his Yankee acquaintance. "He is not here any more," was the reply. "A year ago they sent him down to Mexico with a bunch of Pullman cars, and he lost them!" One would not ordinarily think of a Pullman coach as an easy thing to lose, but, on reflection, it may not be so difficult after all. At any rate, this story indicates the fact that those in charge of activities at Angus have knocked about extensively and have possibly acquired a broad viewpoint of men and means without which their present achievements would have been impossible.

One complete shop has been devoted to the production of shrapnel shells. Its capacity is 3000 of these per day, although it must be said that, in common with most other Canadian shell-producing shops, this capacity is seldom reached due to an insufficient supply of the shell forgings.

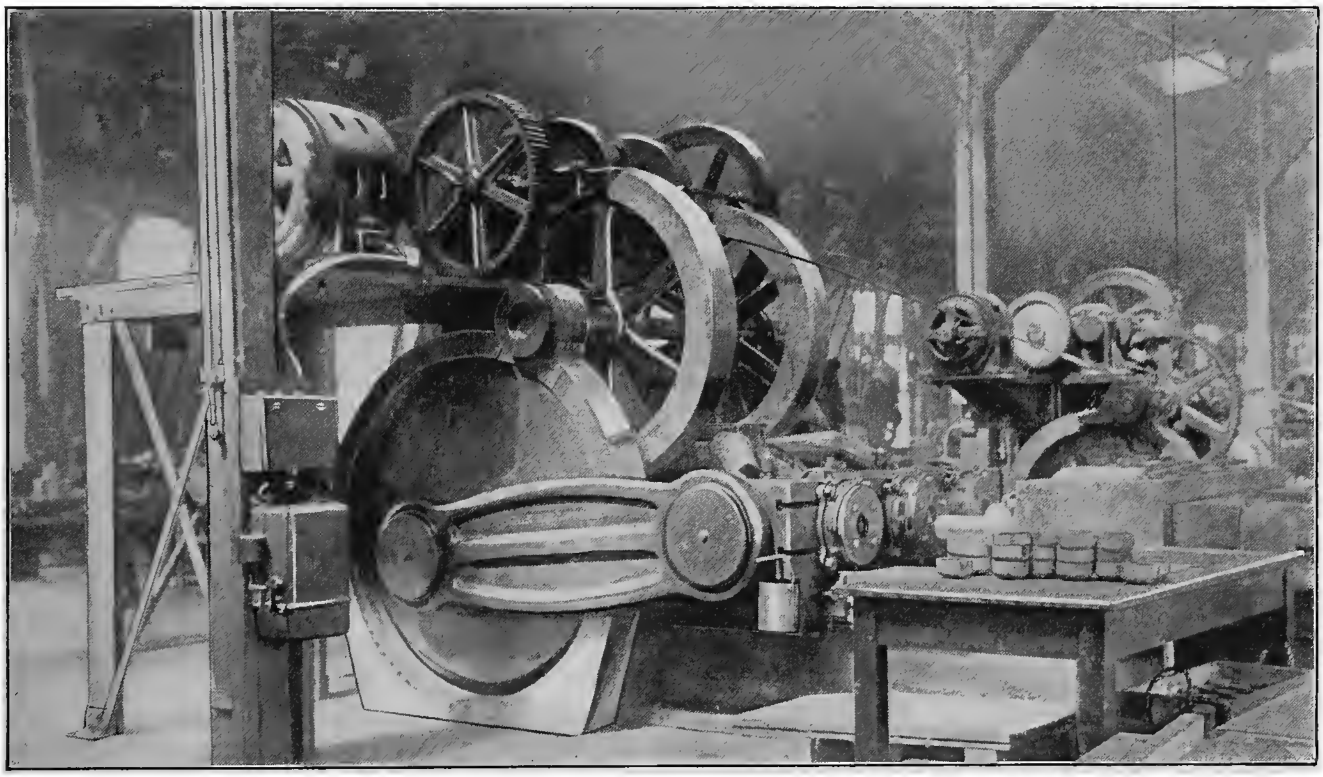


FIG. 8. BULLDOZERS HAVE FOUND A NEW FIELD OF APPLICATION

MAKING CARTRIDGE CASES ON BULLDOZERS AND FROG PLANERS

It would seem that as we apply it, experience opens one door a little wider and at the same time closes a dozen others. In other words, those whose experience has taught them a definite way to do a thing seldom think of other ways radically different, but equally practical. Improve-

FIG. 9. FROG PLANERS DRAWING BRASS CARTRIDGE CASES

ments, if they come, are made on the basis of the original methods. What the world loses or what it gains by this instinctive habit is hard to tell. But sometimes experience and precedent get a severe jolt that upsets them considerably, and this has taken place at the Angus shops in the matter of cartridge-case drawing. A shop in which freight-car trucks were formerly assembled has been pressed in use as a shell-drawing department. Bulldozers and frog planers have taken the place of specialized shell-drawing machines and, strange to say, have done the job equally well, if not quite as rapidly.

It is not hard to think of the idea after you have seen it carried out, but it needed some such jolt as the shock of war to produce the idea. As compared with the delay and expense which would be necessary to put in a specialized equipment for this work, the Angus shops have undoubtedly made a good investment. And after the war is over, if some Canadian-Pacific foreman is told to go ahead and build a flying machine, or something equally difficult and unknown to him, it is not likely that he will say "I don't know how" or "I never did that kind of work before," but he will *go ahead with what he's got and get it out!*

Contraband

The attitude of the United States is substantially to make no recognition of contraband or noncontraband goods. This was manifested clearly in August, 1914, by an order sent to the custom officials of this country, directing them to clear all shipments without distinction as to their nature or destination. The sole restriction is that the vessels must be reputable ones. This declaration officially settles our idea of neutrality as permitting anyone to purchase from us anything that he desires, but it does not tell the American shipper how to keep these goods from being seized.

The deciding factor for the shipper is really the conception of contraband in the minds of those who are in a position to hold up and confiscate his shipment. The list is a constantly changing one, new bulletins being issued every few weeks by each of the belligerents. The latest contraband items of interest to the mechanical industries in this country were declared by the British Government on Dec. 23, 1914:

ABSOLUTE CONTRABAND

Arms of all kinds; projectiles and parts; gun mountings and parts; range finders and parts; articles of camp equipment and parts; armor plate; copper, unwrought and part wrought, and copper wire; warships, including boats and destructive parts of such a nature that they can be used only on a vessel of war; aëroplanes and aircraft of all kinds and component parts and accessories; motor vehicles of all kinds and component parts; implements and apparatus designed exclusively for the manufacture or repair of munitions of war or for the manufacture or repair of arms or war material for use on land and sea.

Under the heading of "Conditional Contraband":

Vehicles of all kinds other than motor vehicles and component parts; railway material, both fixed and rolling stock, and material for wireless telegraph and telephone; horseshoes and shoeing material; field glasses, telescopes, chronometers, and all kinds of nautical instruments.

The last item under Absolute Contraband, *"Apparatus designed exclusively for the manufacture or repair of munitions of war,"* is the real stumbling block.

Making Shell-Forging Presses

EDITORIAL CORRESPONDENCE

SYNOPSIS—The shell-forging presses for the Nova Scotia Steel Co. were built in the Canadian-Pacific's Angus shops. The first press was designed, machined, erected, tested and shipped within three weeks of the receipt of the order calling for it. This article describes the construction and operation of these presses and also tells how various parts were handled on machines that were too small for the job. A successful 30 per cent. steel mixture used for several of the large castings is also described.

Things which are now being done in the mechanical world are of interest, if for no other purpose than to show what can be done, and while it is deplorable and unfortunate that these unusual examples of achievement have been directed toward destructive rather than constructive ends, one may hope that the new standard of progress now established will remain after its incentive has changed from a war-like to a peaceful basis.

All belligerent nations have no doubt responded equally to the spur of necessity in producing war materials. The shops in Canada which have come under observation have been like a machine department with the piece-price earning limit removed—they have established new records both for costs and deliveries.

In this article an achievement of the latter kind will be described. For any shop to design, machine, erect, test and ship a 62,500-lb. hydraulic press within 20 days of the receipt of the first intimation that such a job was to be tackled is a real achievement in delivery, especially as work of this kind was foreign to the shop in question. This press was the first of five which were built for the Nova Scotia Steel Co. at the Angus shops of the Canadian-Pacific R.R. Four of these presses had a 45-in. stroke, exerting a total pressure of 268 tons; one of them had a 36-in. stroke and a total pressure of 322 tons. The same patterns were used for both types, the cylinder wall being left thicker on the smaller-capacity press. The average weight of each completed press was 62,500 lb. The first intimation that these were to be built came Jan. 11, 1915, and the first press was completely assembled and tested on Jan. 31, and was shipped the same evening at 6 p.m.—one of the evident advantages of being a railway shop consisting in the ability to get cars on which to ship goods at short notice.

The action of the forging press will be made clear by the following description in connection with Fig. 2:

The heavy base casting *A* aids the support of the cast-steel cylinder *B* by means of four heavy steel bars shown at *E*. The plunger *D* carries the upper platen *C*, which is forced downward as shown by the dotted lines when water under pressure of 1500 lb. to the square inch is admitted to the cylinder. The upper platen is returned to its high position by means of two pull-back cylinders *H*, which are rigidly attached to the main cylinder *B*. These may more correctly be called "push-back" cylinders since their function is to push upward the plunger *G*, which elevates the top crosspiece *F*, to which the upper platen *C* is attached by means of the bolts *J*.

Tee slots are provided in both the base and the upper platen for the attachment of plungers and dies with which to draw the steel shell forgings. The diagrammatic illustration, Fig. 2, is not a correct representation of the press,

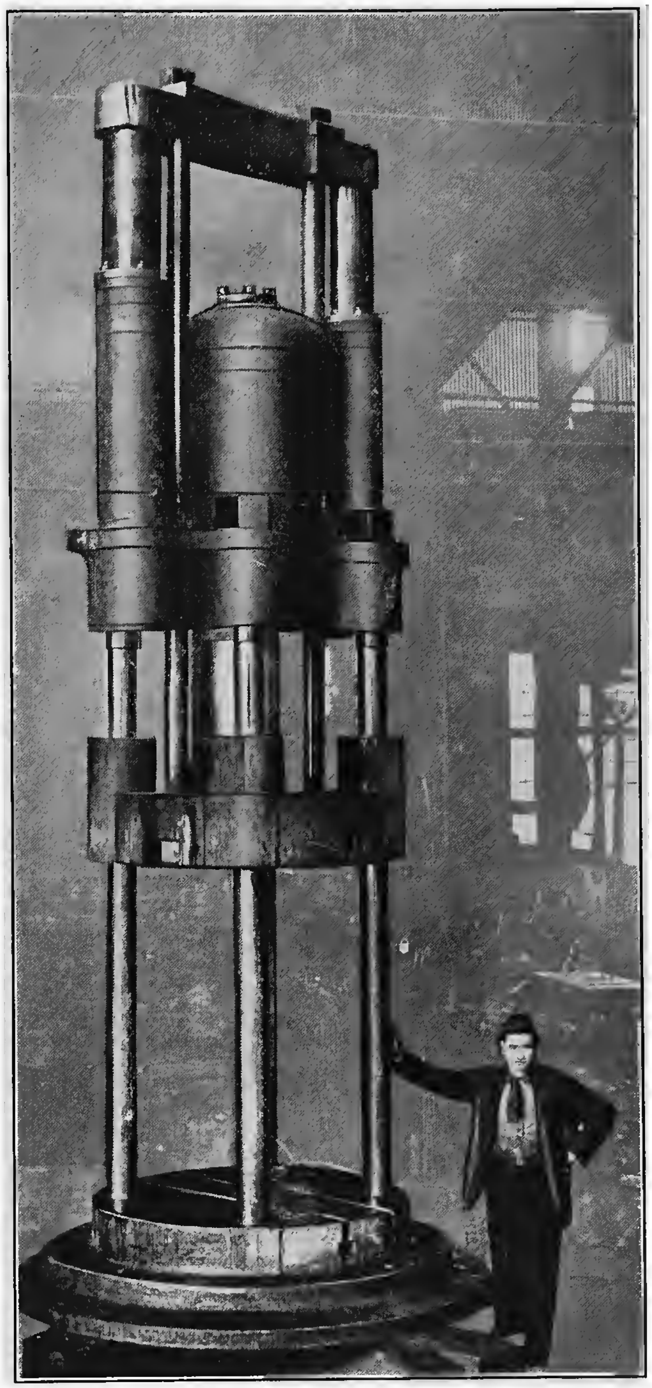


FIG. 1. HYDRAULIC SHELL-FORGING PRESS BUILT FOR NOVA SCOTIA STEEL CO.

being purposely distorted to make its action clear; an assembled view of the machine as actually built will be found in Fig. 3. The press is, of course, a vertical one and is operated by water pressure in connection with a system of hydraulic accumulators.

All sorts of liberty in design was allowed Angus by the Nova Scotia Steel Co. Its order was: "Give us a vertical press for making shrapnel shells, capable of exerting 268-tons pressure and with a 45-in. stroke, and give it to us quick." With this meager information to start with, designs and drawings were completed in three days. It is true that the draftsmen worked until 10 at night and the tracings were not made until afterward, pencil drawings being used in the shop for the first press. But in spite of these facts, one may put this down as a notable drafting-room achievement, especially when he calls to mind draftsmen acquaintances who would take more than this length of time to work out some insignificant detail. These designs had to be right from the start, for when

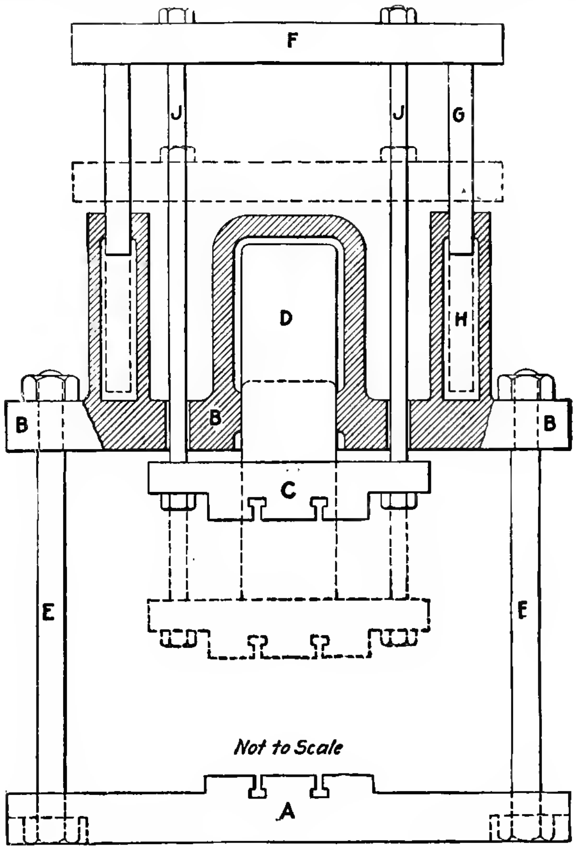


Fig. 2. Diagram Showing Action of Shell-Forging Press

things move in such a hurry there is no time later on to go out in the shop and change designs.

The Patterns and Castings

Sweeps were used wherever possible in order to economize time in the foundry and pattern shop, but those patterns that were built were made in a substantial manner and gave no evidence of being intended for a rush job. The press cylinder is made of steel. The average American accustomed to ordinary steel foundry deliveries would at this juncture throw up his hands and say, "Good night, quick shipment!" But the same germ must have inoculated the steel foundry that had gotten into Angus' system, for within one week after receiving the pattern, the foundry delivered the casting.

The other principal castings of the press—base, platen and ram—are made from a 30 per cent. steel mixture cast at the Angus foundry. This contains silicon 1.4, manganese 0.8, sulphur 0.14, phosphorous 0.5, combined carbon 0.8, total carbon 3.2. Castings made from this mixture have run as high in tensile strength as 30,000 lb. to the square inch.

The flasks for this hurry-up job were in most cases those at hand which came nearest to fitting the piece. In some instances they were none too large, which necessitated shaking out rather quickly after the casting had solidified

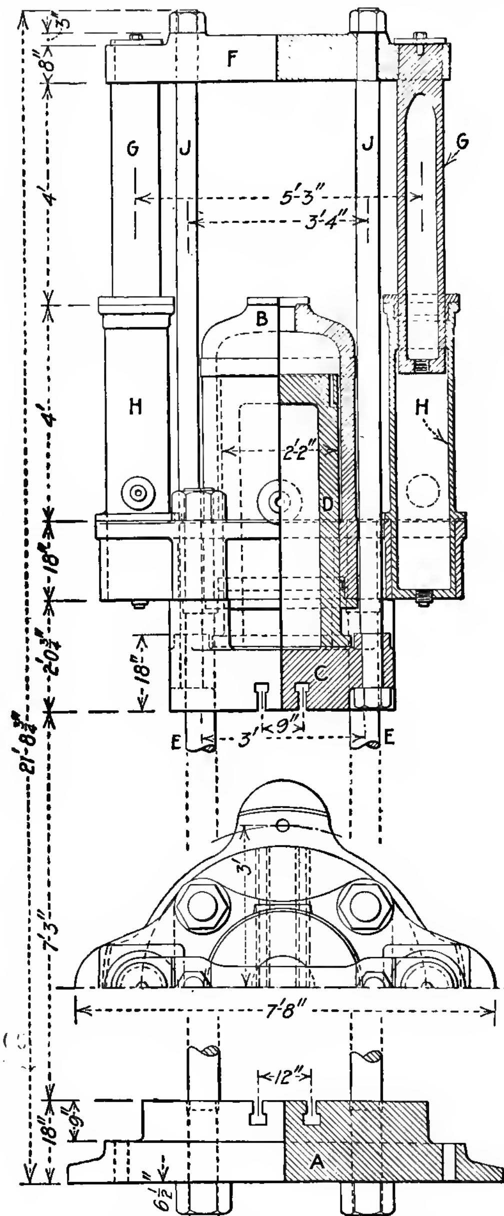


Fig. 3. Assembled Cross-Sectional View of 26x45-In. Shell-Forging Press

to prevent the flasks from being injured by burning. A peculiar result of this necessity will be apparent later in the article.

Forging the Guide Bolts

The large round bars used for bolts for the press were made of billets that were fortunately at hand, although one cannot put it beyond the capabilities of Angus blacksmiths to weld three or four driving axles together into a billet of sufficient size.

The cast-steel cylinder offered the most difficulties of any of the parts in connection with the machining operations because of the bolt holes and pull-back cylinder seats which had to be bored in exact alignment with the cylinder proper, exactly spaced and equally distant from the cylinder center line.

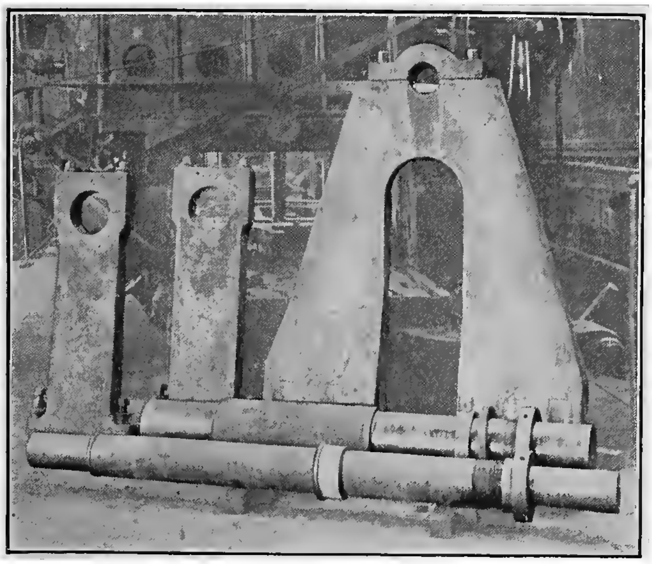


Fig. 4. Fixtures Used in Boring Press Frames and Locomotive Axles Used as Arbors

The casting was first rough-planed on a Morton draw-stroke planer, a tool that corresponds in usefulness in the railroad shop to the open-side planer in general contract shops. Next, it was taken to a vertical boring mill, where the central cylinder hole was bored and the lower surface faced.

An interesting arrangement was rigged up for boring the pull-back cylinder seats and the guide-bolt holes; this is illustrated in Fig. 5. The cylinder itself, its center hole already finished on the vertical mill, was mounted on a trunnion *H*, one end of which was fitted with a flanged sleeve *J*, which was turned to the full size of the cylinder bore. Tho other end of this trunnion fitted the smaller hole *K*, which was provided for the purpose of supporting the core and which was finished on the vertical mill at the time the central hole was machined. The trunnions *H* extended beyond the cylinders at each end and rested in the supports *B*, upon which the cylinder was swung about its center line much as a small piece is rotated in an index head. This permitted the eight holes on the three center circles *E*, *F* and *G* to be located with much exactness. The work table *D* being independent of the headstock and tailstock permitted the boring bar *C* to be located without trouble at the correct center distance.

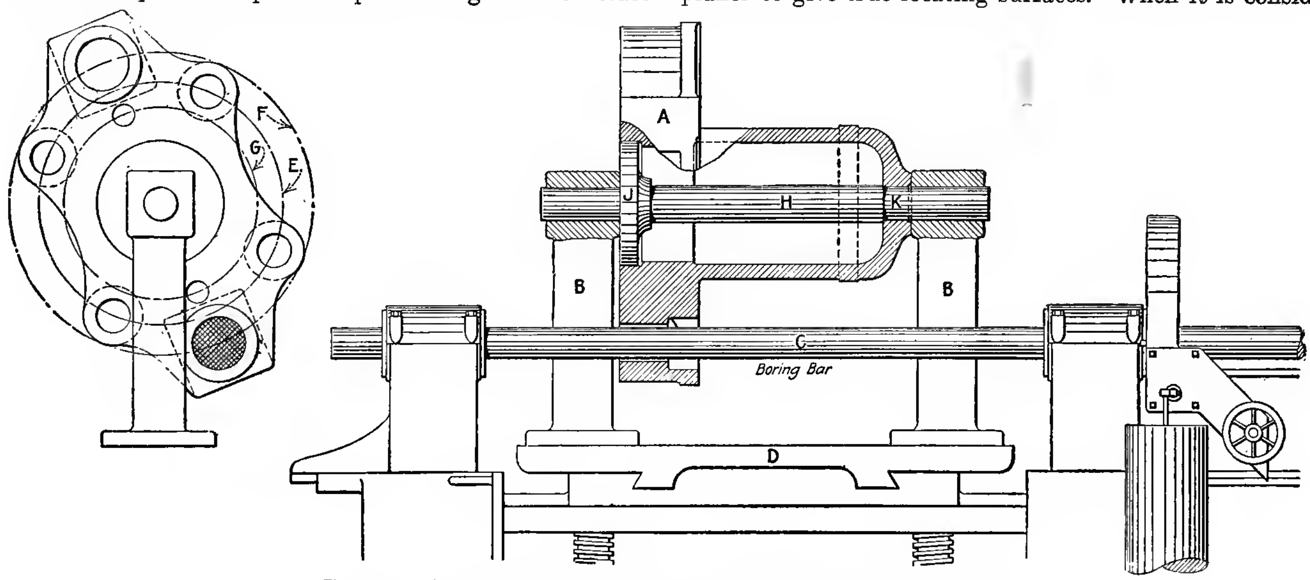


Fig. 5. Arrangement for Boring Cylinder Bolt Holes

An Advantage of This Plan

One advantage of this plan aside from accurate centering was in permitting to be bored at one chucking holes which were too far apart to be within the table traverse of the machine. It also avoided the overhanging of heavy work when extreme table movement was used. The first cylinder, which was made without the centering fixtures, required one inch more than the maximum table traverse. This was obtained by bolting an extension cross-feed screw collar one inch outboard of its normal position; the feed screw itself fortunately being long enough to permit. The overhanging table was supported by lifting jacks upon which were placed pieces of heavy, flat bar steel surmounted by short steel rollers upon which the table moved. This arrangement gave the required support without friction and was necessary to prevent the table from snapping off under such an excessive overhanging weight.

The base and top-rail were machined in a similar way. Center holes for chucking were first bored on a large radial drill, after the castings had been spotted on a planer to give true locating surfaces. When it is considered that the alignment of this center hole determined the alignment of the long supporting bars and that a slight error would be greatly multiplied in the length of the bar, it will be seen that the radial drill and its operator had a job on their hands. The boring bar was, of course, supported by a pilot bushing in the drill base.

Plugs for these castings were made to fit the center holes and extend on each side, forming trunnions on which they were swung for boring in a manner similar to that employed for the cylinder shown in Fig. 5.

The threads upon the supporting bars and in the nuts were all cut in the lathe by means of threading tools. In spite of the extreme rush in which the job was completed.

a full set of gages for the supporting bar threads was made—not only the full threads, but gages for several stages in its cutting.

Erecting and Testing in One Night

The press was completely erected and given a hydraulic test in one night which is evidence of the fact that it went together without a hitch. Having such long bolts to contend with and but $\frac{1}{32}$ in. clearance on the long guide holes of the platen, the slightest error in machining would have caused great delay. When the top cross-piece was finally dropped into place, the erected press cleared the traveling crane by just one inch.

If there were any machinists or others employed at Angus with a disposition to be apprehensive of Zeppelin attacks from overhead, their nerves were no doubt shaken a bit by something that happened during the progress of the work.

In war time, and when working on war material, it is not reassuring to have one's ears assailed by a loud explosion. But the cause of the disturbance was nothing

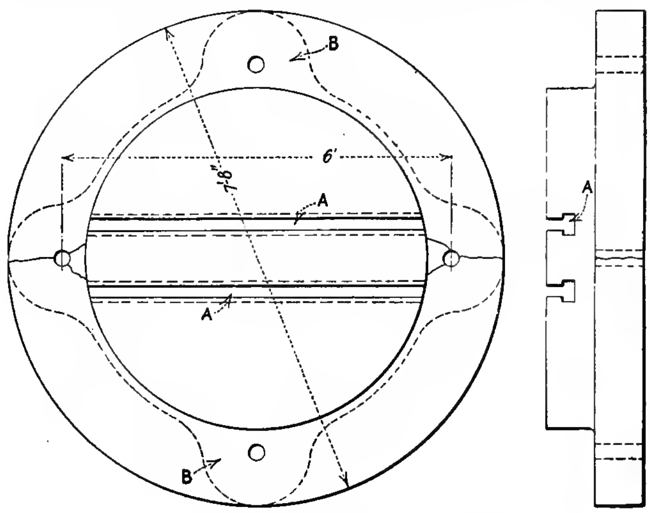


Fig. 6. The Casting that Exploded

more formidable than one of the large base castings for the press which had quite suddenly exploded! This base casting, a 30 per cent. steel mixture, was made as shown by the heavy lines in Fig. 6. The bolt flange was a continuous circle, and tee slots were cored in the upper surface, as shown at *A*. Heavy steel blocks used to support these cores had the effect of weakening the structure in a definite line. When the casting was pulled out of the sand and wheeled while still hot into the freezing atmosphere without, enormous stresses were set up within the casting which resulted, a few days later, in its violent rupture. The redesigned base is shown by the dotted lines in Fig. 6; this minimized the danger from shrinkage stresses.

What Made Quick Delivery Possible

Most of you will admit that to put a new job of this kind through a shop in such a short time is a noteworthy achievement. Absolute coöperation all through the ranks made this possible. You do not find this in ordinary times. A good shop manager may be able to arouse a remarkable degree of enthusiasm and coöperation, but it is not really solid—there are holes in it here and there. Let someone discover the formula for producing the real 100 per cent. simon-pure article by which every man puts his whole heart unreservedly into his task, and achievements of this kind will be comparatively easy. Unfortunately, nothing short of war seems to furnish incentive enough to accomplish this result.

Armored Motor Truck

The Bethlehem Steel Co., South Bethlehem, Penn., and the Thos. B. Jeffery Co., Kenosha, Wis., have combined their engineering skill to produce the armored motor truck shown in the illustrations.

The chassis is that of a Jeffrey quad truck, with a four-cylinder water-cooled gasoline engine, developing approximately 50 hp., which drives through a transmission, located in the center of the chassis frame, to all four wheels. The transmission is arranged for four speeds forward and four reverse, with a maximum speed of 30 mi. per hr. Each wheel is provided with a steering knuckle, embodying the combination of four-wheel drive and four-wheel steering. The four-wheel steering feature enables the truck to be turned in a circle of 44 ft

This combination permits of the truck being driven and steered either forward or reverse with equal ease. A self-

Bullet-Proof Motor Truck

starter is fitted and, as a precaution in case of failure, a hand-crank starter is also provided; this can be operated by the driver from his seat without his exposing himself to the enemy's fire.

On exhaustive tests it was proved that this truck could not be stalled under any circumstances or conditions which could reasonably be imposed upon any kind of self-propelled vehicle. With a full load, the truck was driven through mud in which it sunk up to its axles, up an incline including a 49-per cent. grade, and across a rough stretch of country which presented obstacles from 2 to 3 ft. in height.

To the chassis frame is attached a structural framework of angles and channels, designed with a view to giving maximum flexibility combined with necessary strength, on which the armor plate is carried.

All armor plates have been ballistically tested and have withstood a bullet from a service rifle at a 50-yd. range.

Drawing 18-lb. Cartridge Cases on Bulldozers and Frog Planers--I

By John H. Van Deventer

SYNOPSIS—The demands of war cause machines to be put to unexpected uses, and their operators to develop unthought of capabilities. That bulldozers and frog planers could be adapted to the accurate requirements of brass cartridge-case work is almost beyond the range of possibilities. Yet it is successfully done at the Angus shops, and the detailed description of the process is begun in this article.

One of the editors of the American Machinist was conversing several months ago with an official of a large brass-drawing plant—a man of great skill and experience.

"Have you heard," queried the editor, "that in Canada they are making cartridge cases on planers and bulldozers?"

"I have heard it rumored," replied the expert, "but can hardly believe it. They may have, in a crude way, performed one or two operations on such machines, but beyond that it would seem impossible."

With these words he expressed the probable opinion of the 99 out of every 100 of those versed in such work.

As a matter of fact, at the Canadian-Pacific's Angus shops they are using these apparently unsuitable machines for every press operation except heading and indenting, and they are not only getting a high-grade product, but they are rapidly nearing their ultimate capacity of 3000 cases per day. Moreover, there is not one man employed on this work who had previously worked in a brass-drawing shop or had experience of a similar nature.

Arrangement of the Cartridge Department

A truck-shop building was cleaned out and made over into the cartridge department. The arrangement of machines, inspecting room, pickling and washing tanks and other equipment are shown in Fig. 2.

A bit of dust or grit on one of the drawing dies or plungers makes an ug[illegible] scratch in the case, and it was considered more advisable to keep this shop free from smoke and dust than to try to avoid transportation. Therefore, as the nearest available building for the annealing furnaces was the blacksmith shop across the midway, this shop was used for the drawing operations, and the indenting and heading presses were also installed there.

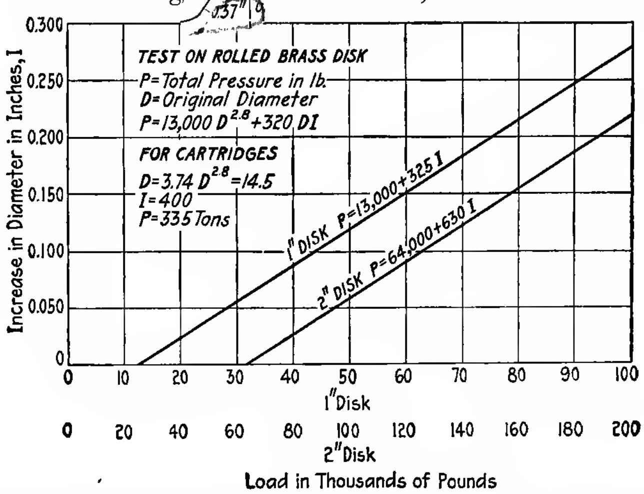


Fig. 3. Curves Showing Relations between Stress and Strain in Cartridge Material

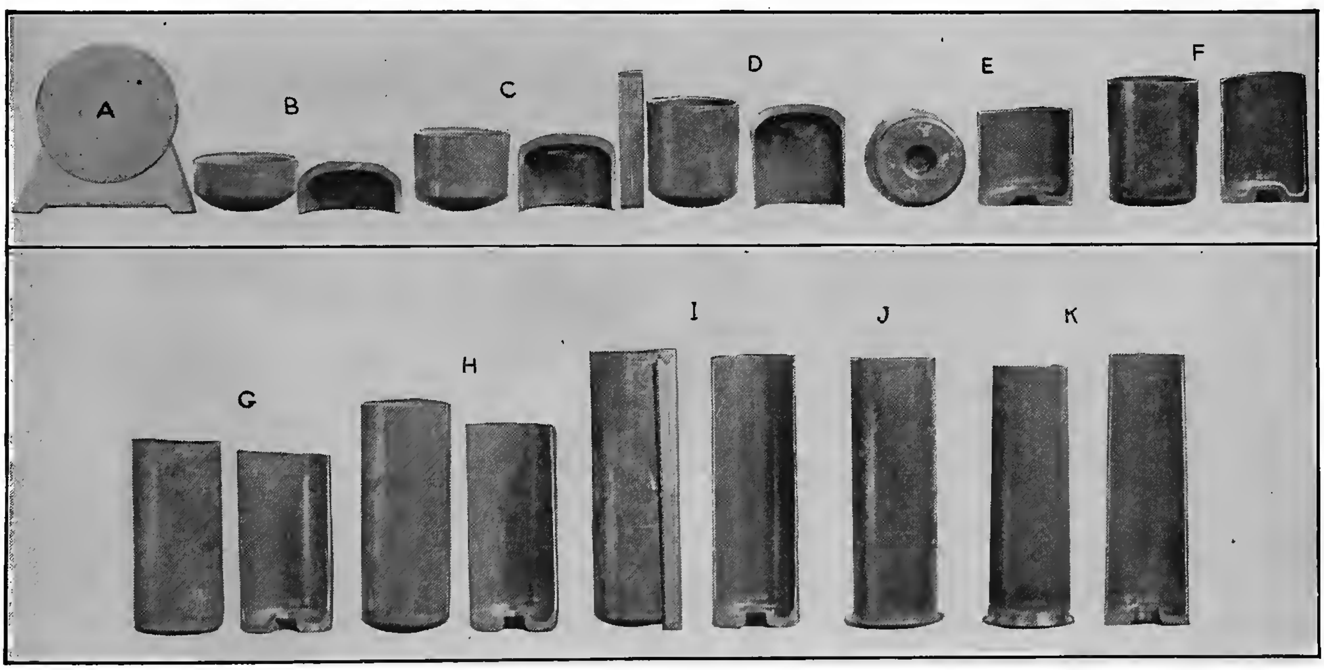


Fig. 1. The Evolution of a Cartridge Case

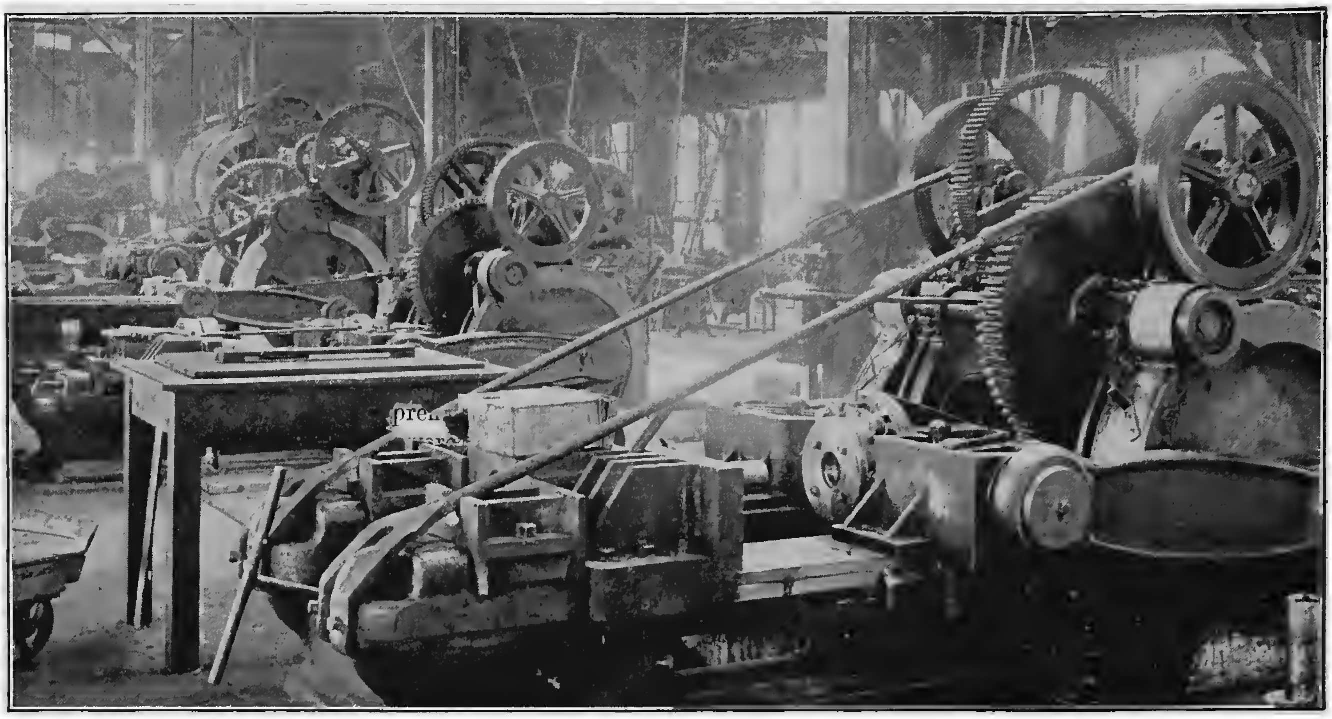


Fig. 5. Bulldozers in a New Rôle

List of Operations

The operations as performed on cartridge cases at the Angus shops are as follows:

1. Blank
2. Cup
3. Anneal
4. First draw
5. Anneal
6. Second draw
7. First indent
8. Anneal
9. Second indent
10. Anneal
11. Third draw
12. Anneal
13. Fourth draw
14. Anneal
15. Fifth draw
16. First trim
17. Anneal
18. Sixth draw
19. Second trim
20. Head
21. Semi-anneal
22. First taper
23. Second taper
24. Head turning
25. Parallel cutting
26. Stamp
27. Shop inspection

There are six drawing and seven annealing operations; the cupping and first four draws are handled on bulldozers, and the last two draws, on frog planers. The round blank is punched out of strips of sheet brass, and each disk weighs 3 lb. 9½ oz. at the start. By the time it has become a finished case, it has lost $1\frac{1}{10}$ lb. due to trimming, the finished weight being 2.49 pounds.

All stages in the process are represented in Fig. 1. The round, flat blank punched out of strip brass is shown at *A;* the cup made directly from this is shown at *B,* and *C* and *D* represent the first and second draws respectively. The indented case is shown at *E,* the indenting being performed after the second draw. The third, fourth, fifth and sixth draws are shown at *F, G, H* and *I*. At *J* is the headed cartridge case, while *K* repre-

Fig. 4. Tote Boxes Used for Transporting Brass Cartridge Cases

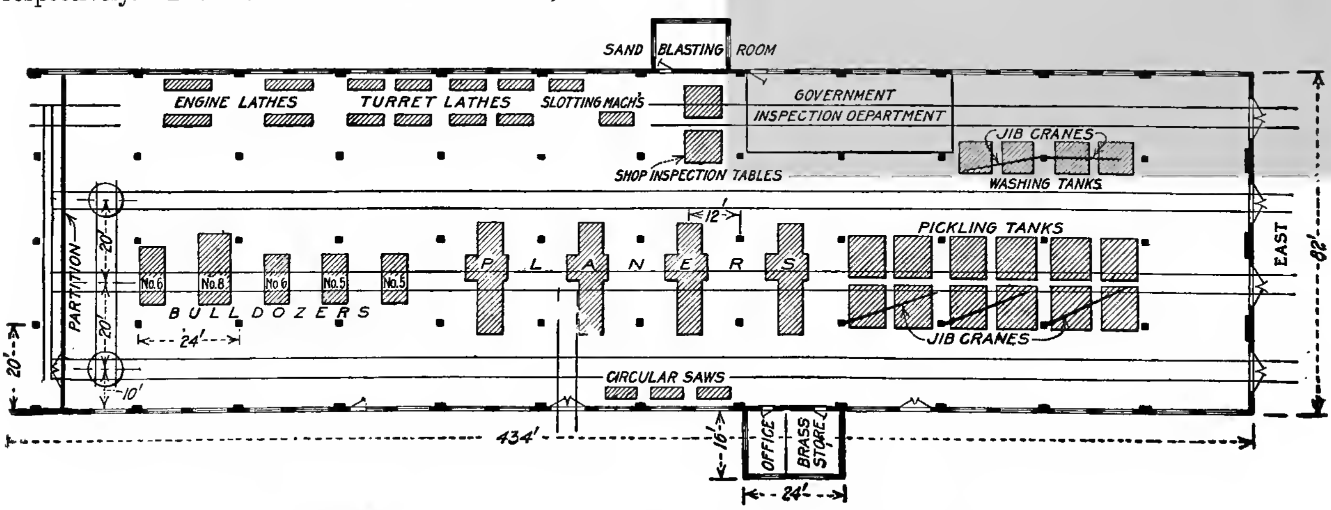


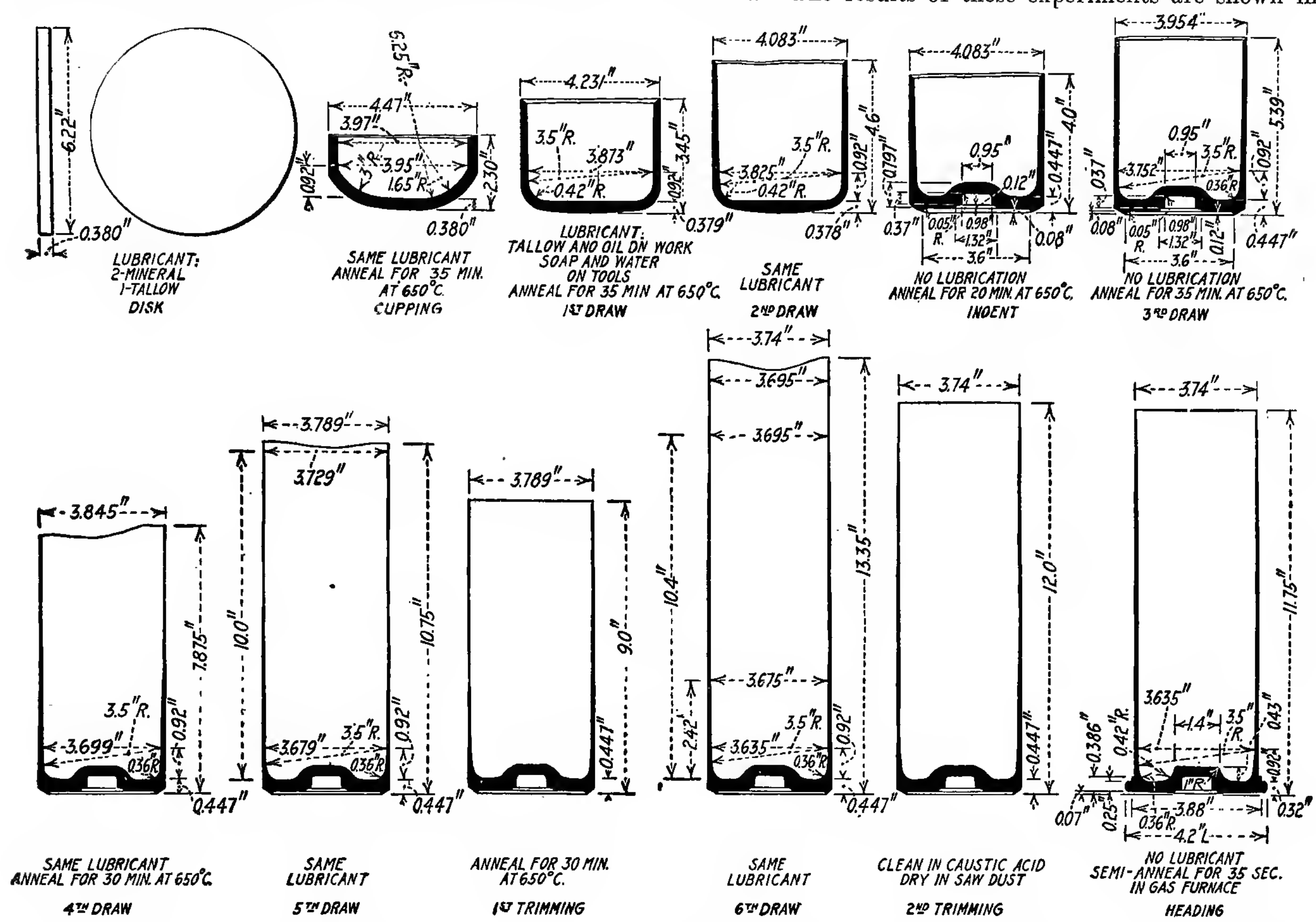
Fig. 2. Diagram Showing the Arrangement of Cartridge Department at the Angus Shops

sents the completely tapered case with its base machined and ready for the primer, which, of course, is not furnished at this shop nor attached until the complete cartridge is in government hands.

Motor-Driven Machines

The bulldozers and planers are all motor-driven. There are four of each of these machines, one of the bulldozers being provided with three sets of plungers and dies and the others having but one set each. On the bulldozers, the die is mounted on a special crosshead, and the plunger, on the rail. On the planers, the punch is mounted on the rail. and the die-holder, on an angle-block on the table.

Little was known at the start about the pressures required to accomplish the various drawing and heading operations. To throw light on this subject, experiments were made with brass disks of the same composition as the cartridge cases, the effect of pressure upon them being studied. The results of these experiments are shown in Fig. 3, and they served as the basis for calculations when the presses were built.



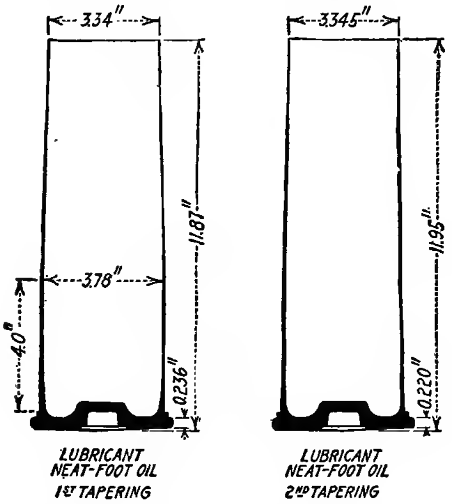


Fig. 6. Various Stages of the Case Reproduced from Actual Sections

The evolution of the punches and dies for this work was a matter of much labor on the part of the toolroom foreman, W. M. Whitehouse, and while Mr. Vaughn, of the Canadian Pacific, was assured in his own mind of the practicability of drawing such work on bulldozers, it was a matter that had to be proved, no precedent being known for such novel use of a machine of this type. The first set of plungers and dies were worked up to be tried on a single bulldozer. After experiments extending over two weeks' time, successful cases were produced, and when the first three of these had been secured, the Canadian Shell Committee was notified of the feasibility of making cartridge cases in this way. The entire committee was at hand within a day or two to witness the demonstration of bulldozers in their new rôle, and as a result, a large contract for cartridge cases was placed with the Angus shops.

The Bulldozers

The bulldozers in the cartridge department are shown in Fig. 5. The machine in the foreground has seen about 20 years of active service and would scarcely be considered a suitable device for producing accurate work. It answers the purpose in first-rate manner, however, although re-

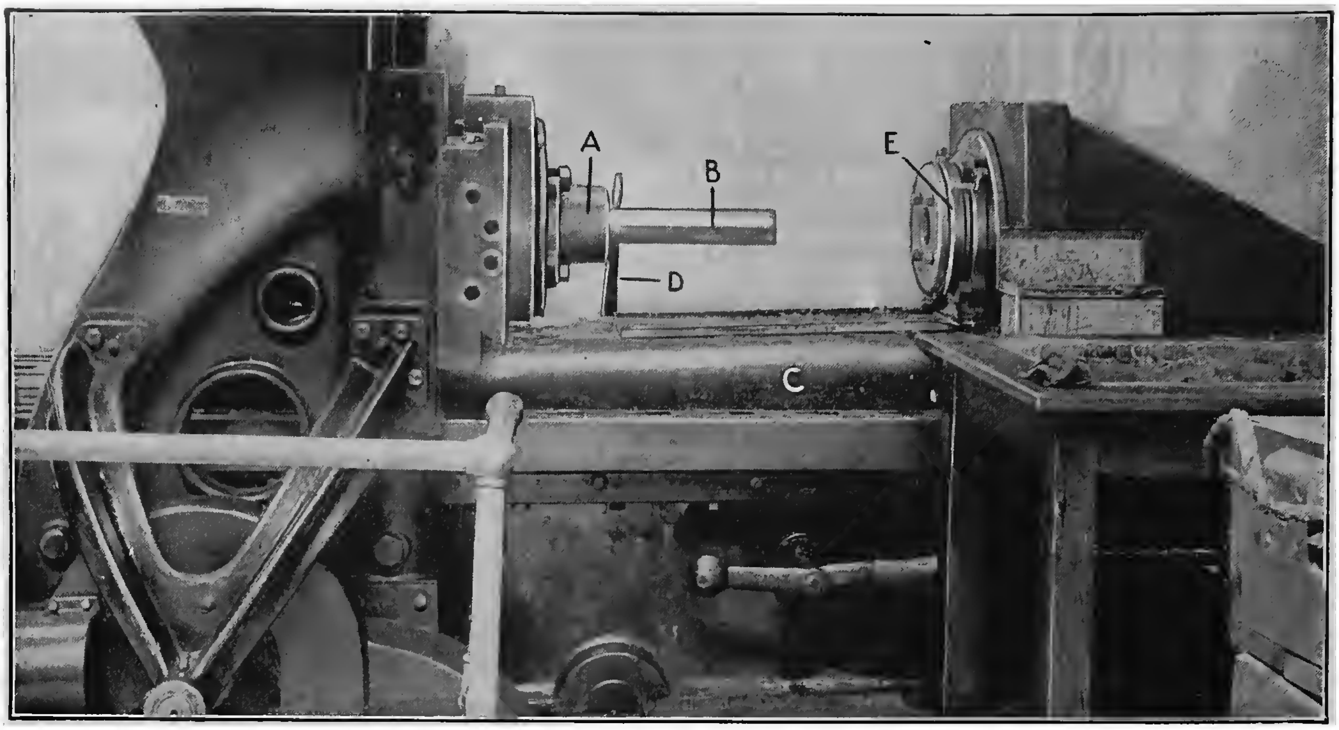


FIG. 10. FROG PLANER USED FOR THE LAST DRAW

quiring the assistance of brace rods to overcome the spring.

One of the bulldozers, a modern machine, has been equipped with three sets of plungers and dies. The center one takes care of the cupping of the disk, while the two outside ones handle the first draw. A recess is provided behind the plate *D*, Fig. 7, to hold the flat disk as the plunger advances. Plates of this kind are necessary only for the cupping operation, as for all of the succeeding draws the cup, or shell, is slipped over the plunger while it is in its withdrawn position.

An ingenious method of discharging the pieces after each operation has been devised in the simple form of galvanized-iron conductor pipes, as shown at *A*, *B* and *C* in Fig. 7. These convey the pieces to the back of the machine, where they roll down a chute into boxes. As

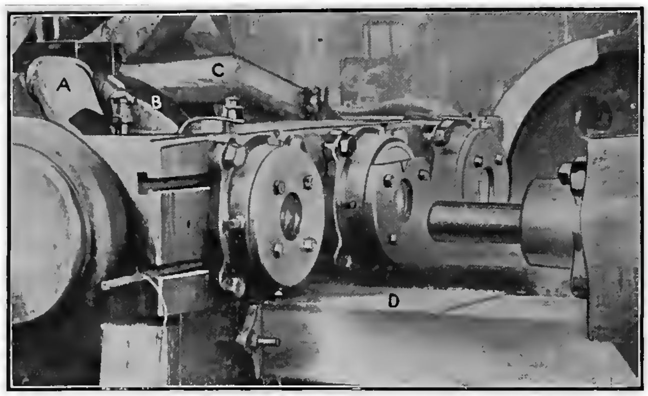


FIG. 7. BULLDOZER DIES FOR THE CUPPING AND FIRST DRAWING OPERATIONS

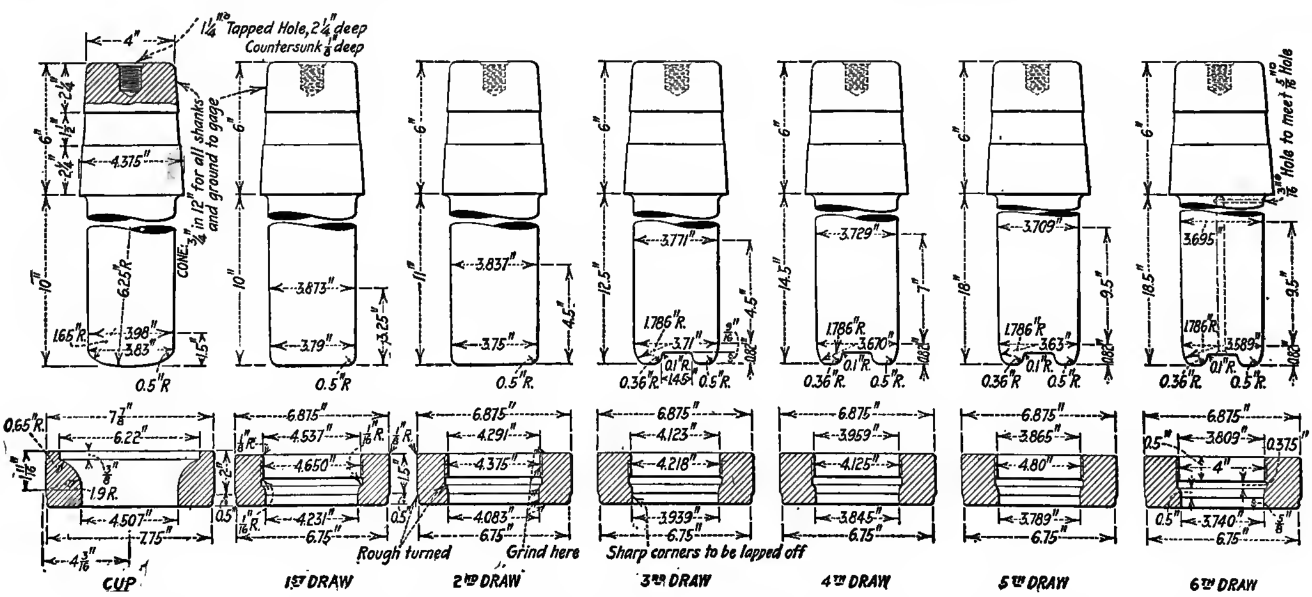


FIG. 9. DETAILS OF THE PLUNGERS AND DIES USED FOR MAKING 18-LB. BRITISH CARTRIDGE CASES

each case passes through the die, it pushes forward the ones ahead of it, causing them to climb the hills in the pipes.

The Planers

Frog planers are used for the last two draws for two reasons—first, they have a longer stroke than the bulldozers; second, they are more accurate. One of them is shown in Fig. 10. A special head has been mounted on the planer cross-rail, from which the feed screws have been removed, and upon this the plunger holder *A* is secured, the plunger *B* fitting into it on a standard taper. As shown at *E*, the die is held upon a heavily ribbed cast-iron angle-block which is in one piece with the casting *C*. The whole thing weighs some four or five tons and serves not only to secure the die-holder, but also to prevent the table from rising.

Good Reasoning Employed

At first thought, the natural plan would apparently be to mount the die-holder upon the cross-rail and the plunger upon the angle-block. There is a good reason for the opposite procedure, however, since any lift that occurs during the operation will undoubtedly take place in the planer table and not in the cross-rail, which is a rigid member. The plunger, on account of its long overhang, would be thrown out considerably by a few thousandths of an inch rise of the table; whereas the die, having a thickness of but 2 to 2½ in., is not perceptibly affected, as evidenced by the fact that the thickness of shell in these cartridge cases does not vary over one-thousandth of an inch.

In determining the suitability for a planer for the last two draws, a bulldozer cross-head was clamped upon a

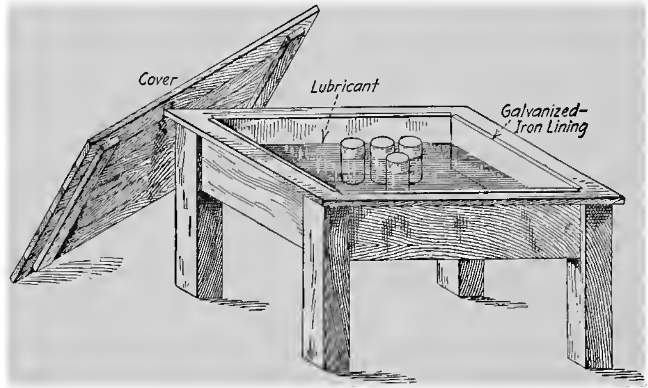


Fig. 8. Lubricant Tank-Table

planer table and the punch was put upon the clapper block. After the feasibility of the machine was demonstrated, a cut was taken off of the table top and one side so that they indicated to $^1/_{1000}$ in. The die- and punch-holder seats were then bored with a long bar lined up from the table and both holes finished at one setting.

Tote Boxes and Lubricant Tank-Tables

The cases are transported in tote boxes, as shown in Fig. 4. Four hundred cases are considered a "lot." To this, 10 per cent. is added as an allowance for loss, although

Fig. 12. View in the Blacksmith Shop Showing Annealing Furnaces and Metal Annealing Baskets

it must be said that the average to date has been considerably less. Two more cases are added to each lot for the firing and proof tests, so that the total "lot" number as it originally starts through the factory is 442.

A convenient combination of work table and lubricant tank is shown in Fig. 8. It consists of a wooden table, containing a galvanized iron-lined lubricant tank in which the shells are stood until the operator is ready for them, thus insuring a good coating of lubricant. These tables are easily portable and are provided with covers which prevent dirt from getting into the tanks when not in use.

Annealing Baskets

In the process of annealing, which takes place after every draw, considerable attention has been given to the design and construction of suitable containing baskets. Some of these are shown in Fig. 12; they consist of angle-iron frames with heavy wirecloth lining on two sides and having angle-iron reinforcing bars. The illustration also gives an idea of the type of furnace used; these are oil-burning and were built at the Angus shops. The heat is controlled by means of pyrometers, and the temperature recorded on Bristol recording gages. Annealing is an important and critical operation since the grain of the metal changes perceptibly with but slight differences in the annealing temperature, and if this is not carefully regulated, the percentage of loss is materially increased.

The limits on cartridge-case work are rather close, especially at the base end and in the primer holes. Detailed dimensions and the high and low limits are shown in Fig. 11.

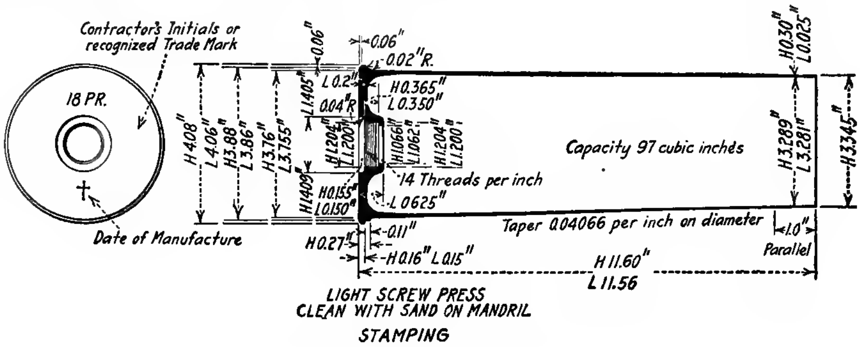


FIG. 11. DETAILS AND LIMITS OF A FINISHED 18-LB. BRITISH CARTRIDGE CASE

To Machine-Tool Builders

During the past three or four months many have commented upon the disturbed conditions in ocean freight, insurance and exchange rates, pointing out that this situation might have an important bearing upon the marketing of machine tools in Europe. Shipping conditions have been a hindrance to foreign trade for several months. In many cases machines have lain on the dock in New York for several weeks before steamer accommodations could be found to take them across.

But a more serious situation than anything yet faced may arise, provided the belief now existing in certain American business and financial circles should prove to be a prediction. This belief is that the European war may suddenly end.

Many American machine-tool builders are now working on war orders. Those already booked in many cases will take four, five, or even seven months to complete. It is not believed that in all cases these have been surrounded with all the possible safeguards against cancellation. Fresh inquiries are constantly coming in and new orders are being placed. What will be the effect upon these orders if the war should suddenly stop?

The natural effect of any overturn of business conditions is to spur men to remove financial responsibilities as rapidly as possible. If we turn back to the period following the year 1907, we will recall the flood of machine-tool cancellations. The sudden close of the European war might easily throw another flood of cancellations upon the builders.

This would be a severe calamity if it came at a time when the shops were running above normal capacity, as they are today. It takes some weeks for any large manufacturing plant to gather momentum, and the greater the momentum of a moving object, the worse the crash when something hits. Another factor enters from the fact that many of the machines now being built are not of standard proportions. For instance, many engine lathes for turning shells have been ordered 18-in. swing and 6-ft. bed. This bed is shorter than standard for the swing. If a machine-tool builder had an order for a large number of these lathes cancelled after they were well under way, he might have stock which could not be disposed of for several years.

American firms who have taken orders for ammunition, such as shrapnel, rifle cartridges, and explosives, have guarded themselves against a sudden termination of the war by requiring and receiving a generous part of the purchase sum at the time the order is closed. These sums are said to range from 30 to even 50 per cent. of the total amounts of the orders. Such orders have as a rule been placed by foreign government agents, and thus are on a little different footing than orders for machine tools which come from foreign agents or private sources.

Because of the possibility of the rise of a most unfortunate situation, it is wise for the American machine-tool builder to consider some of the business policies of the manufacturers of ammunition. We do not believe that this has been generally done, but have learned of one case where an agreement has been reached in keeping with the provisions of the following quotation, addressed by a machine-tool builder to his agent:

> You are to establish a confirmed credit in New York to be available for payment of our invoices upon receipt by your forwarders of inland shipping documents and invoices. Each credit is to expire by limitation 30 days beyond the delivery date promised by us at the time the order is booked. Partial shipments allowed; all invoices paid as above are to be subject to 2 per cent. discount.

Another machine-tool builder has negotiated as follows:

> You are to pay us one-third cash with the order. The remaining two-thirds are to be paid by sight draft attached to inland shipping documents on arrival of goods at New York. The one-third cash accompanying the order is to pay for the last third of the entire shipment. No cancellation is permissible if the machines are shipped within the agreed time.

This suggestion is of course aimed at new business.

Drawing 18-Lb. Cartridge Cases on Bulldozers and Frog Planers--II

By John H. Van Deventer

SYNOPSIS—This article concludes the description of drawing brass cartridge cases on improvised machines as successfully practiced at the Angus shops. The case-tapering operation is detailed as performed on bulldozers. All of the work is handled on a piece-work basis, even to transportation and other duties performed by laborers. The turret-lathe set-ups for the machining operations on the cartridge case are shown in diagram.

Improvised machinery does not necessarily imply crudeness of method. The work of drawing cartridge cases at Angus is carried on with the utmost attention to detail, and the rough edges in the process have been rounded out so that the whole thing moves with commendable smoothness. The time in which this has been done is so short (less than nine months) that even if the most suitable machinery had been installed, it is doubtful if the process as a whole would have reached a higher degree of efficiency.

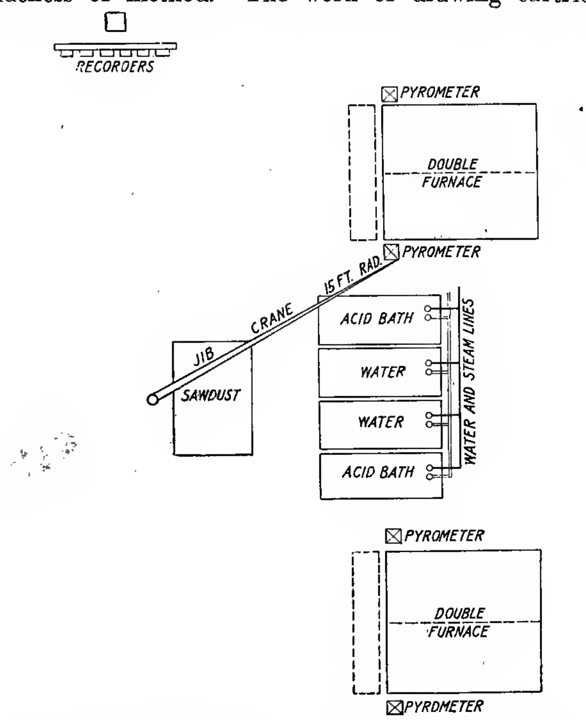


Fig. 1. Arrangement of the Heating Furnaces

One of the first things undertaken was a careful estimate of machine capacity with the view of securing a balanced equipment. Some speed data in connection with the bulldozers and planers may be of interest.

Speeds of Bulldozers and Planers

The bulldozer which handles the cupping and first draw has a working stroke of 24 in., makes 240 strokes per hour and has a speed on the effective stroke of 18½ ft. per min. The bulldozer on the third draw has a 20-in. stroke and makes 240 strokes per hour, having an effective speed on the working stroke of 16½ ft. per min. The planer on the fifth draw, with a stroke of 37½ in., runs at an average of 130 strokes per hour and an average speed on the effective working stroke of 11 ft. per min.

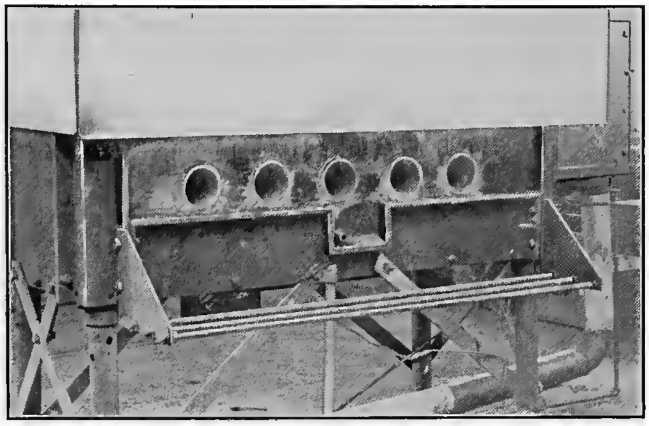


Fig. 2. Gas-Fired Semi-Annealing Furnace

Piece Prices on Machine Operations

All of the work on cartridge cases at Angus is done on a piece-work basis. Some of the pieces are reproduced below and show that even with machines far different from those that would be considered suitable for this purpose, an excessive labor cost may be avoided.

Cupping—One operator and helper. Helper to fill tank with disks and 13 boxes of 34 at the rear of machine and return empties. Per 100—27c.

First Draw—One operator and two helpers. (Double operation.) Helper to fill tanks with cups, 12 boxes of 36, one box of 10 and return empties. Per 100—21c.

Trimming—Operator only. Per 100—18c.

Buffing—Operator only. Per 100—10c.

Tapering—Oil and taper (first and second complete). Operator and helper. Per 100—52c.

The heating furnaces for the reason outlined in the

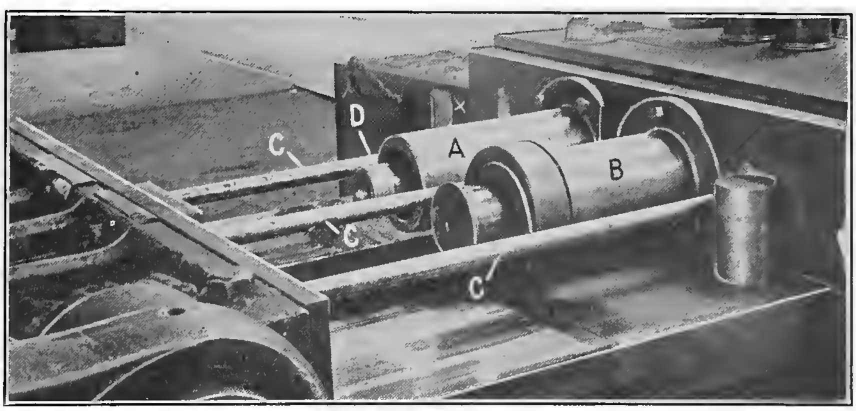


Fig. 3. Bulldozer Rigged Up for Tapering Cartridge Cases

last issue were set up in the blacksmith's shop, a building across the way from the cartridge department. These furnaces were built by the Angus shops and are arranged in groups, as shown in Fig. 1. The baskets of hot cases are handled from the furnaces to the quenching tanks by means of overhead swinging jib cranes, which have been lengthened somewhat for this purpose.

Semi-Annealing

A heat-treating operation known as "semi-annealing" is performed just before the tapering is done. The furnace in which this is accomplished is shown in Fig. 2. Like all the others at this plant, it uses crude oil as fuel. The peculiar feature about the semi-annealing operation is that the cases do not come in direct contact with the flames, being placed inside of incandescent cast-iron tubes, the ends of which are clearly apparent in the illustration.

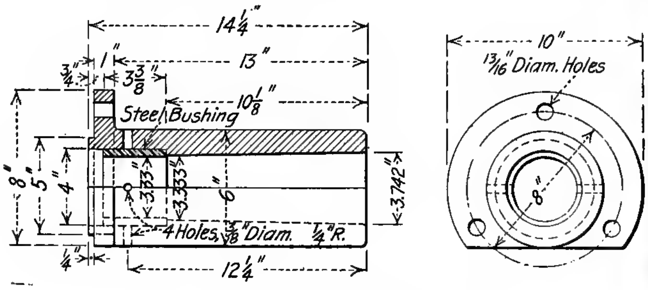


Fig. 4. Second Tapering Die

For dipping the product in the washing tanks, in which the cases are freed from the lubricant before they go to the annealing ovens, angle-iron washing baskets of a type similar to those employed in the annealing furnaces illustrated in Fig. 12, page 879, are employed.

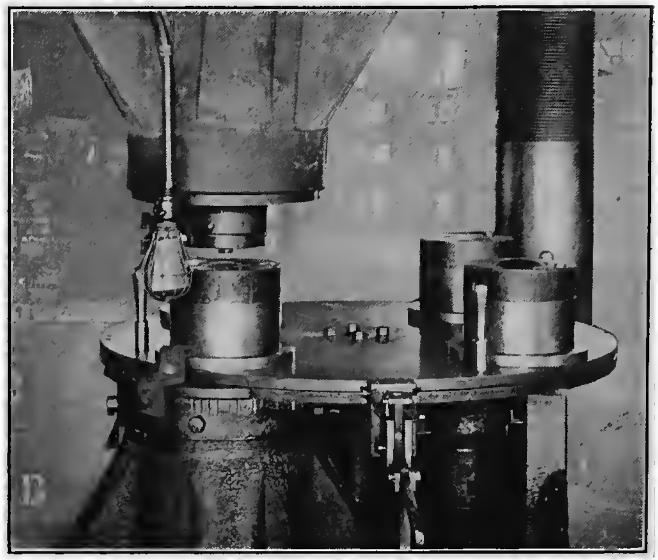


Fig. 5. Indenting Press

Very substantial wooden dipping boxes are used in the acid tanks. These are shown in Fig. 11 and are made out of 2-in. stock. Two of these lengthwise fill one acid tank; they are handled by means of air hoists from swinging jibs.

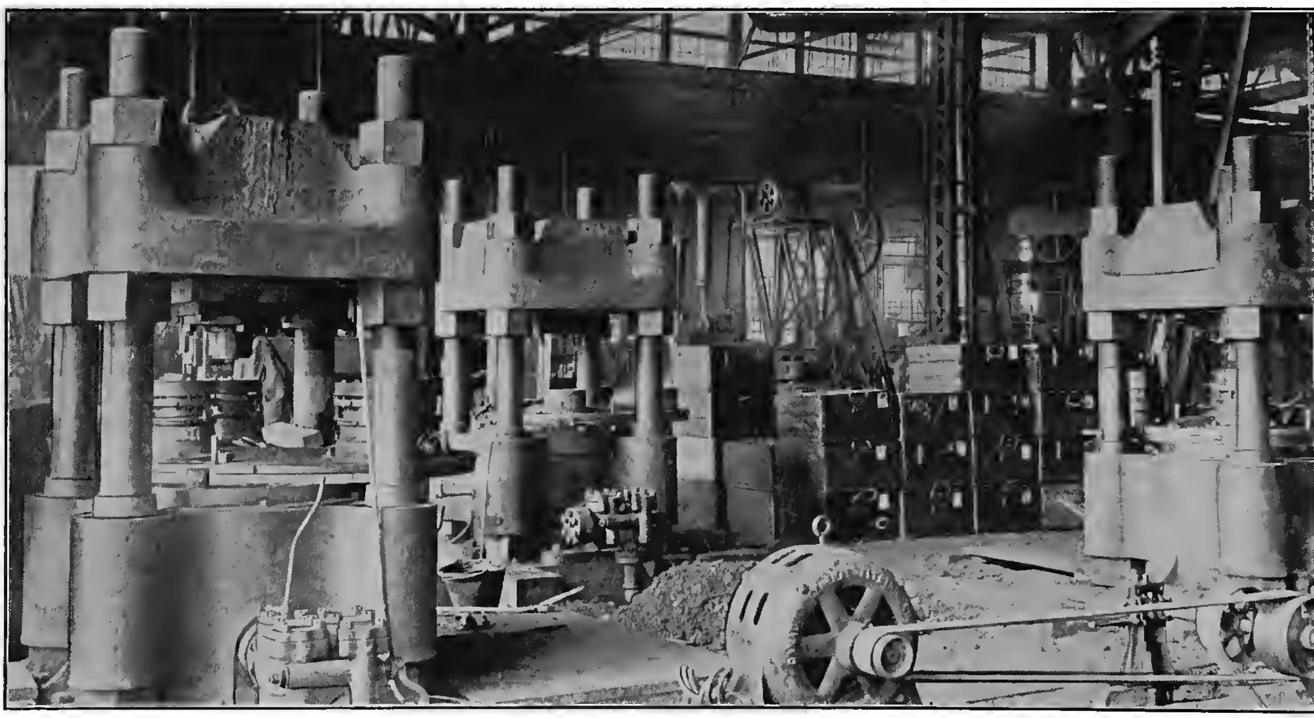


Fig. 6. Group of 800-Ton Heading Presses

After coming from each machine operation in which a lubricant is used, the cartridge cases are washed in boiling lye water to avoid excessive scale and smoke during the annealing. In addition, each batch of cases coming from the annealing ovens must be pickled to remove the scale, which would injure the dies. The acid bath for this purpose consists of 2½ parts sulphuric acid to 20 parts of water.

Piece Prices for Handling and Washing

Even the operations performed by laborers are worked out and paid for on a piece-work basis, some of the prices being as follows:

Wash—In lye or water. Per 100—10c.

Wash—In acid. Per 100—20c.

Trucking—To or from wash tubs to machine (in cartridge department). Per lot of 442—20c.

Trucking—To or from wash tubs to annealing ovens (blacksmith shop). Per lot of 442—45c.

Annealing Ovens—Operator and four helpers. Remove from boxes and replace after annealed ready for trucking. Per 100—33c.

Pressing the Taper

One of the most interesting operations in the entire process of making cartridge cases is that of tapering. This

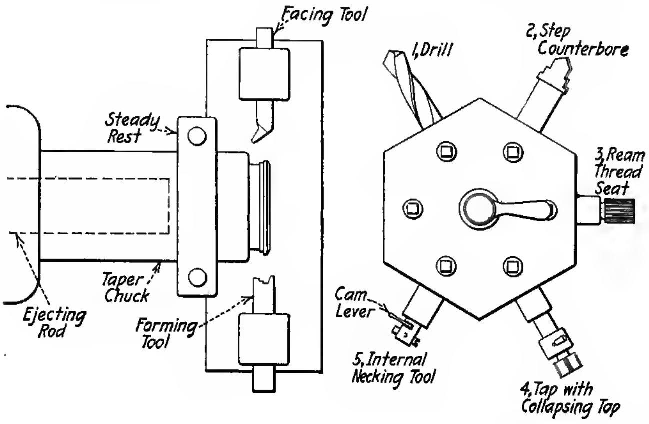


Fig. 7. Turret Lathe Set-Up for Finishing Base and Primer Hole

is done on a bulldozer, and the arrangement for this work is shown in Fig. 3. There are two steps in the tapering operation, both of which are completed on this machine. The first taper is given the case in the die *A*. After it comes from this die, it is further tapered and finished in the die *B*. The case is inserted in each of these dies by hand and is pressed home by means of the cross-

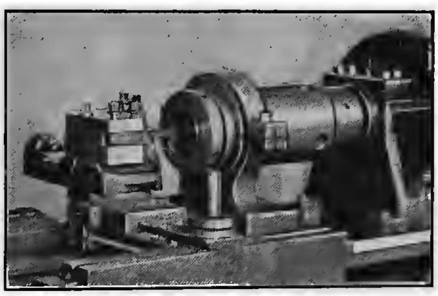


Fig. 8. Engine Lathe Rigged with Special Chuck and Tool Block for Finishing Open End

head of the bulldozer. It is ejected after the stroke is completed by the return of the cross-head through the medium of the pull-back rods *C*, which actuate the ejector plugs *D*. Correct annealing for this operation is a very important matter, and unless this is assured, there is a tendency for the case to wrinkle. A detail drawing of the second tapering die is shown in Fig. 4.

After the tapering operation, the cartridge case is sent to the turret lathes so that the base and primer hole may be machined. The set-up for this work on Bertram turrets is shown in Fig. 7. The production for this operation on these machines averages eight cases per hour.

The next operation is known as "parallel turning." It consists of cutting off the open end of the shell to proper length and also of thinning down the thickness of wall on the inside so that the hole will pass a limit-gage test. This operation is performed at the rate of 30 per hour on a modified engine lathe equipped with a special tool post and chuck, as shown in Figs. 8 and 9. Both the base

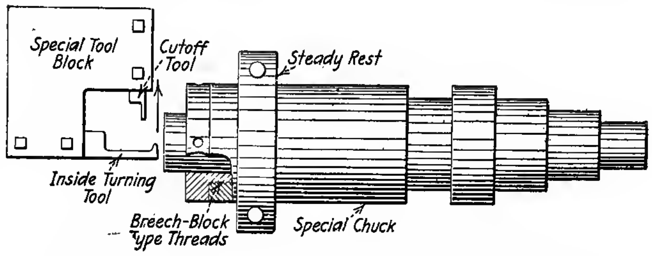


Fig. 9. Engine Lathe Set-Up for Cut-Off and Parallel Turning

and open-end turning will be done in the near future on Bullard cartridge lathes, which handle the two operations simultaneously at the rate of from 20 to 25 cases per hour.

An ingenious and time-saving vise is shown in Fig. 10. It is used at the benches for retapping the primer hole, which is purposely left a little full in size and brought to full standard by means of a hand tap. This vise holds the case on its taper by friction and is fitted with a quick ejector operated by foot power.

Methods of Inspecting and Testing

The government inspectors carefully search for defective shells, as a flaw in one of these would cause much

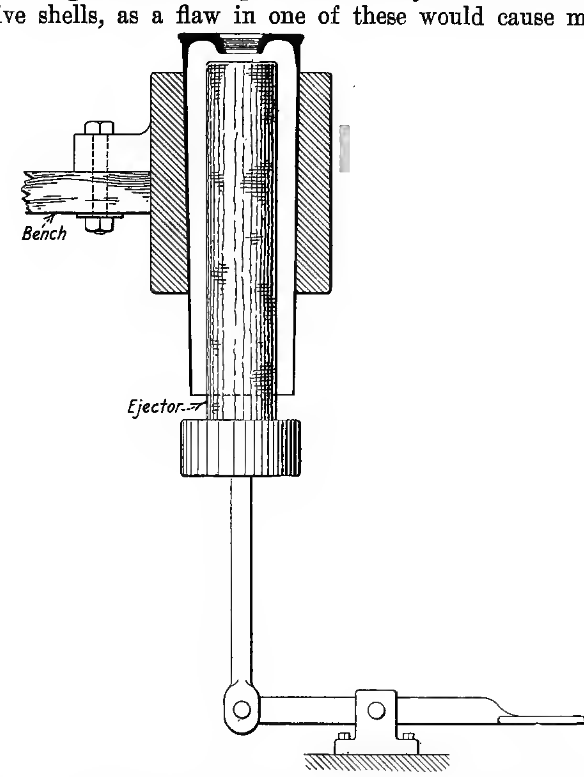


Fig. 10. Special Bench Vise for Holding Cartridge Cases

injury to a field gun. One of the defective work reports is shown in Fig. 14 and will serve to illustrate the nature of the defects as they are classified. Some of them are rectifiable and others cause the immediate and absolute rejection of the case.

Two cases out of every 400 are subjected to government tests, which are known as the proof and firing tests. The former is conducted by subjecting the shell to explosions, the pressures of which are carefully measured. It may be wondered how the intensity of an explosion can be measured. This is very simply done by the arrangement shown in Figs. 12 and 13, which is a device purposely constructed for finding such pressure.

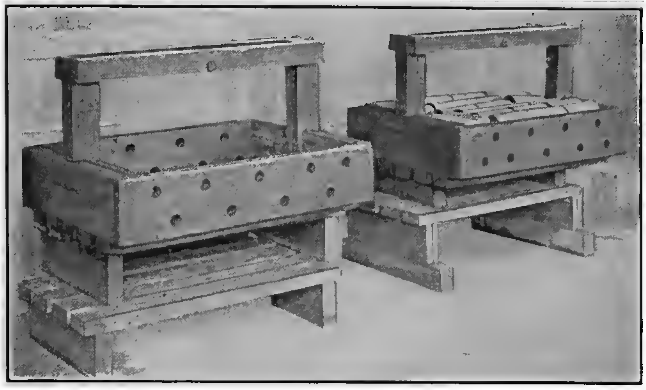
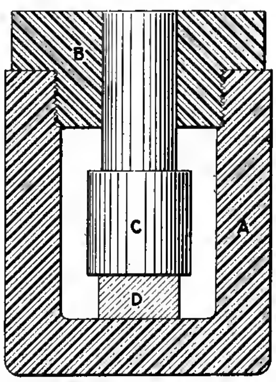


FIG. 11. WOODEN ACID-DIPPING BOXES AND DIP STANDS

A steel cylinder *A* is provided with a cap *B* in which the piston *C* fits snugly, its top surface being exposed to the air through the cap *B* and its lower surface resting upon the soft copper plug *D*. In making the proof test, this apparatus is placed inside of the cordite within the cartridge case. When the charge is exploded, the gas pressure, being equal in all directions, presses upon the plunger *C*, Fig. 12, with a certain force per square inch, which causes it to compress the copper disk *D*, which has been carefully turned to a definite size and the resistance



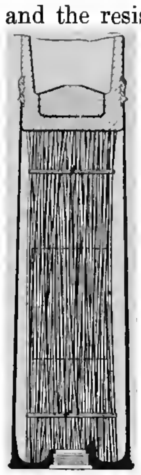


FIG. 12 PROOF-PRESSURE TESTING DEVICE FIG. 13

of which to compression is known. With these factors constant, measuring the increase in the diameter of the disk gives a definite measure of the intensity of the explosion pressure.

TENSILE STRENGTH OF THE BRASS

To stand up against this severe service, the material used for making cartridge cases must be selected with great care. Some typical tests of the strength of this annealed brass are given below.

Tensile strength, tons	Yield, Tons	Elongation in 2 in., per cent.
20.1	5.45	67
20.1	6.38	70
20.5	4.37	62
20.6	6.02	58.5

Some interesting tests have been made upon the pressure required to perform the tapering operations on a bulldozer. For the first operation, to press the cartridge flush with the die requires an average of 7900 lb. The second tapering operation exceeded this greatly, averaging between 19,000 and 20,000 lb. total thrust. The stripping

FORM C. C. 3.

DEFECTIVE WORK REPORT.

CARTRIDGE CASES

Firm.

LOT Total Examined Date.

RECTIFIABLE
High to Chamber gauge
Low Primer Hole
High to Plug Gauge
High to Length
Low to Horse-Shoe Gauge for body
Low to Plug Gauge
High Thickness of Metal at mouth
High Thickness of flange
Toolmarks on body (slight)

Rectified & Passed

NOT RECTIFIABLE
High Primer Hole
High Diameter top of threads
Low Thickness of Metal at mouth
Low Thickness of flange
Low to Length (over .05")
Toolmarks in body (deep)
Flaws
Spilly Metal
Spontaneous Splits
Damaged threads

Rejected Total

Examiner.

FIG. 14. WAR DEPARTMENT INSPECTOR'S REPORT. THIS SHOWS THE DIFFERENCE BETWEEN "RECTIFIABLE" AND "NONRECTIFIABLE" ERRORS

of the tapered cartridge also takes considerable pressure, this varying from 5320 to 11,000 lb.

INDENTING AND HEADING OPERATIONS

The indenting operation is performed on a 285-ton station-type hydraulic press, a machine, incidentally, which was designed and built at the Angus shops.

The cartridge cases are headed by means of three 800-ton hydraulic presses, also built at Angus. These are shown in Fig. 6 and are operated by two large hydraulic accumulators working at 1500 lb. per sq.in. pressure.

The operation of these presses is purposely passed over in this article, as it will be described in the following issue in connection with a description of their design and construction.

Material for Brass Parts of Shells

There are two brass parts in the shrapnel shells made in Canada and the United States that must be assembled before the shell is shipped to Europe. These are, the socket for the fuse and the plug for the nose. The plug is merely used to protect the thread until the shell reaches the battle-field and receives its fuse, when it is ready to fire.

The Canadian Shell Committee advises that the recommended analysis for the metal in these parts is: 58 parts copper, 40 parts zinc and two parts of lead. These pieces are preferably brass forgings pressed to shape under a unit pressure of 75 tons per sq.in.

The specified physical tests are: Tenacity at the yield point, 6 tons per sq.in.; breaking stress, 12 tons per sq.in.; elongation in a 2-in. specimen, 10 per cent.

Cartridge Heading Presses and Accumulators at the Angus Shops

By John H. Van Deventer

SYNOPSIS—In the Canadian-Pacific's process of making the 18-lb. British cartridge case, the operations of heading and indenting are performed on four-station dial-feed table hydraulic presses. These were designed and built at the Angus shops, as were also the hydraulic accumulators which operate them. The design, construction and operation of the 800-ton presses are described in this article, and some interesting machine work on the accumulator parts is shown.

Apparently not contented with the record of making a remarkable adaptation of machines to new purposes, the men of the Angus shops undertook to design and build the high-power hydraulic presses used for indenting and heading cartridge cases. They have not only equipped their own plant with these machines, but have furnished a number to other Canadian concerns that are making the 18-lb. and the 4.5-in. cartridge cases.

Description of the 800-Ton Heading Press

The presses used for heading are built according to the design shown in Fig. 1. The cast-iron plunger of 37

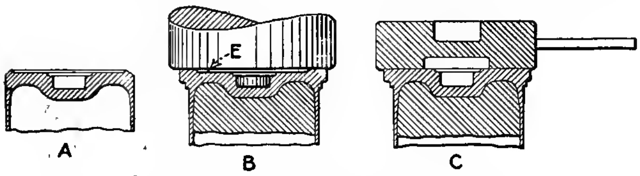


Fig. 3. Stages in Case-Heading the 18-Lb. Brass Cartridge Case

in. diameter, shown at *A,* works within a steel cylinder casting *R.* Water from the accumulator at a pressure of 1500 lb. per sq.in. is admitted and discharged through the cylinder space *G* by action of the three-way valve *F,* which is operated by the foot lever *E.* (The press is set partly underground so that this lever is at a convenient height for the operator's foot.) An equalizing passage *H* is cored in the plunger in order to make the area of the 8-in. guide stem effective. A dial table *C,* mounted above a stationary table *M,* is arranged to rotate upon a center pivot *P.* This table carries four "stations," shown at *S, T, U* and *V.* The rotating table is notched for indexing, which is accomplished through the table-operating lever *D,* which forces a hardened-steel wedge into the locating notch on the moving table.

In the main sectional view, the station *V* is shown directly underneath the punch *B* in correct position for heading a case. The station *S* is in the fourth position, in which the headed case is ejected. A 4½-in. hydraulic cylinder *L* (shown more clearly in the minor section) is located immediately beneath this position. An operating lever *J* actuates the three-way valve *K* which controls the plunger in the ejecting cylinder. When this is caused to rise, it pushes the cartridge case upward until the flange of the case is caught by the spring jaws of the stripping device *O.*

An enlarged view of the station tool-block is shown in Fig. 4, and reference to this will be helpful before taking up the description of the heading operation. The stationary punch *A* is identical with *B* in Fig. 2. The

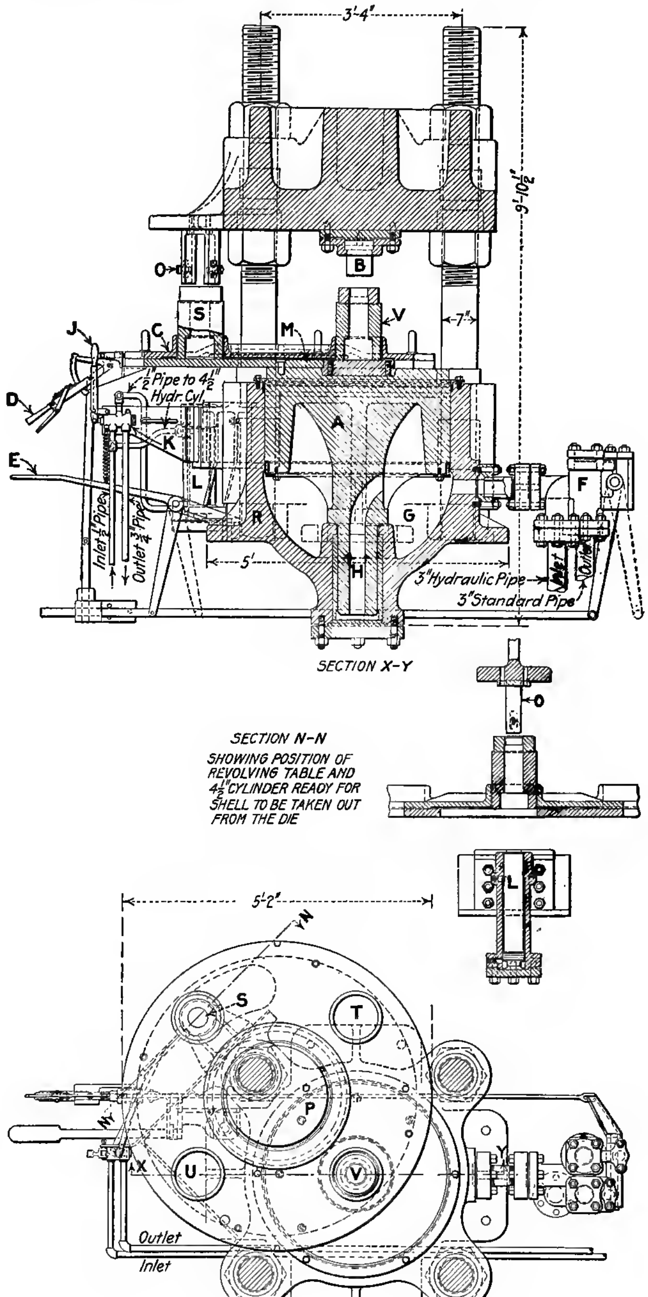


Fig. 1. Sections and Plan of Four-Station 800-Ton Heading Press

die consists essentially of three parts—the base ring *F,* which is bolted within the table-station block and which does not come in contact with the brass cartridge case; the upper ring *E,* which takes the radial pressure caused by the heading operation; and the internal die *B,* the top of which conforms to the shape of the inside of the cartridge base.

During the heading operation on the station *V*, the base of the die *B*, indicated at *D*, rests upon the top of the 37-in. plunger, which raises the entire dial table. While this is in its high position, the ejecting plunger under the station *S* is brought into action, pushing the die *B* upward within the base ring. It will be noted that there is a possible movement of 5¼-in. for this, which is enough to eject the finished case into the stripping device.

At the station *T*, Fig. 1, is the loading position. Here the cases are inserted into the composite die, being hammered down with a block of wood, when necessary. The station *U* is an idle position.

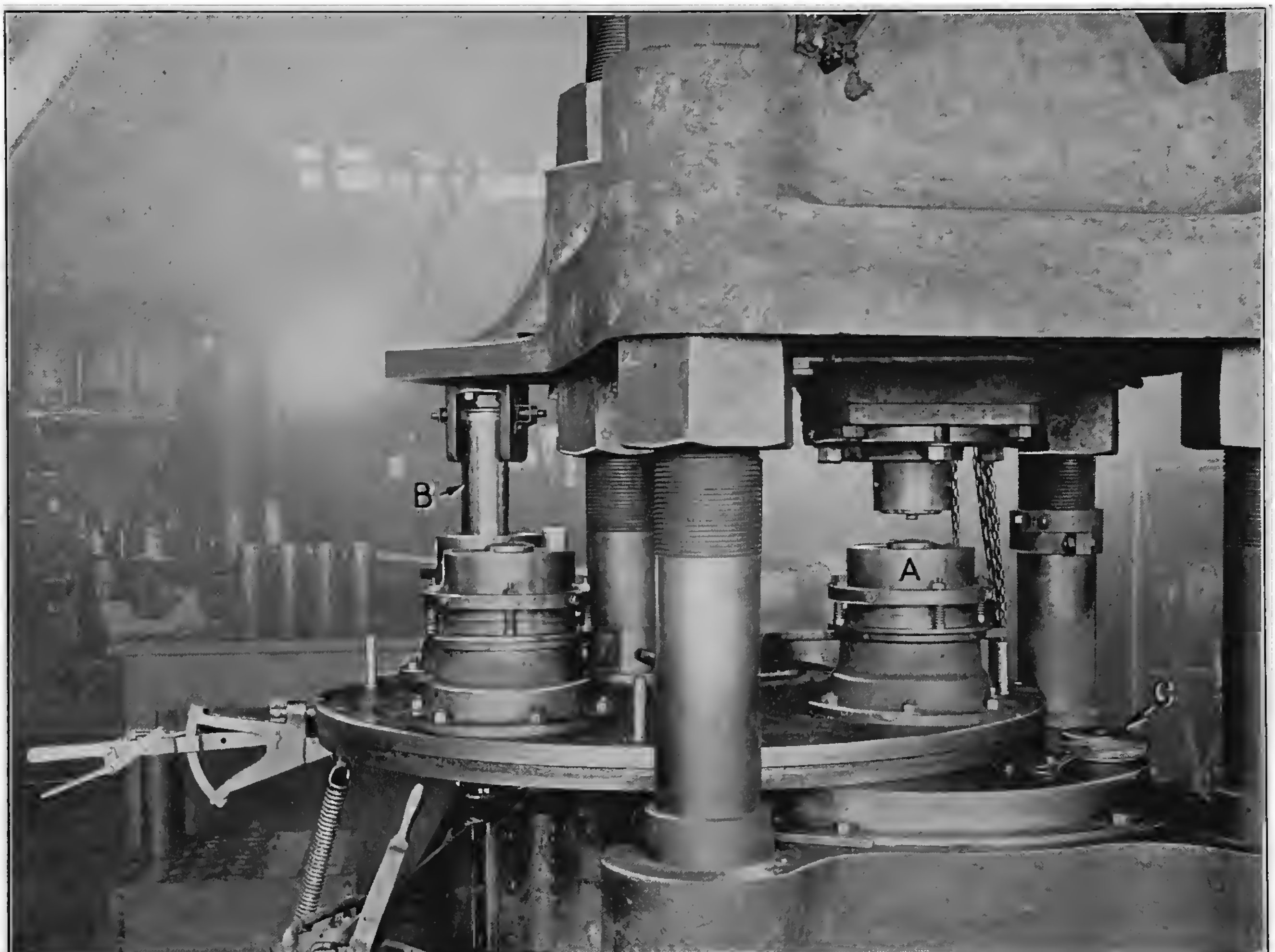


Fig. 2. Hydraulic Station-Type Heading Press for 18-Lb. Cases

At *B* in Fig. 2 is shown one of the 800-ton heading presses, with the cartridge case ejected and caught by the stripping device. The table station shown at *A* in this view represents that in which the actual heading is done. At *C* is shown the fullering die, to which reference will be made later.

The Process of Heading

The process of heading as done at Angus, is shown in Fig. 3. The case as it comes to the heading press is shown at *A*. The first pressing operation, shown at *B*, partially heads the cartridge, but leaves a depression in its central part, as shown at *E*. This is not the final shape of the headed case, this depression being provided in order to spread the metal and make the operation easier. The third step, in which this top surface is smoothed out with a fullering die, is shown at *C*. After the press has performed the operation *B*, the table is lowered and the fullering die is inserted under the stationary punch, it being provided with a recess that fits the protruding part of the latter and centers the fullering block. It is held here by hand while the work is given another squeeze, which produces the smooth, flat surface shown at *C*.

Four men are required to operate one of these presses—the man in charge of the gang operates the machine levers; one of the others takes care of the loading station; another holds the fullering die in the pressing operation and a third helper takes the extracted shell from the stripper and places it in the tote box. The entire time for the operation is approximately 1½ minute.

The full capacity of the press appears to be required to take care of the leading operations.

The Problem of 160,000 Lb. to the Square Inch

Referring to the internal die, Fig. 4, a little calculation will show that extremely high unit pressures were encountered in this work. The projected area of the inside of the base of the cartridge case is approximately 10 sq.in., and the pressure exerted in the operation is a full 800 tons, which means 160,000 lb. to the square inch of internal die surface. The problem was to get metal to stand up under this enormous unit pressure. At first the die was made of high-grade tool steel, hardened as is usual for a tool of this kind, but this was not satisfactory, for it upset the metal in the internal die and soon rendered it unfit for use. The hardening had not penetrated entirely through, and the soft interior had caused the whole die to compress.

After a great deal of thought had been given to the matter, the internal die was made up of laminated pieces, most of these being of the size shown at *C*. These were made of 120.0 carbon steel and hardened glass-hard, care being taken to see that the hardness was not skin deep, but penetrated entirely through. The theory worked upon was that there is practically no limit to the

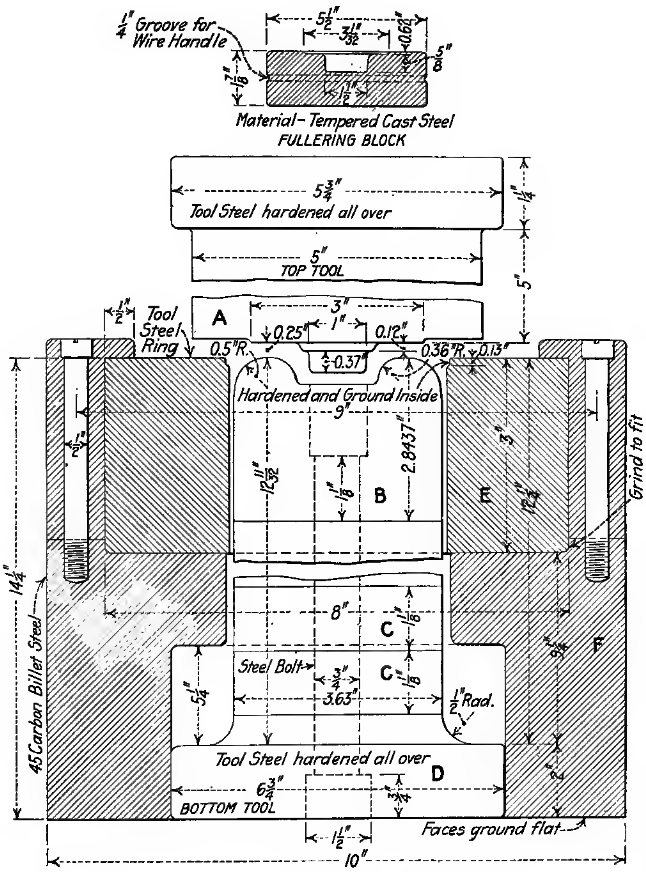


FIG. 4. DETAILS OF HEADING PUNCH AND COMPOSITE DIES SHOWING LAMINATIONS

safe compression load on metal as long as it is unyielding, this quality being secured by the glass-hardening process. Apparently there is something to this theory, for it has worked out successfully, although the upper part of the die *B* occasionally has to be replaced.

It is interesting to note that this construction, which originated at the Angus shops, has been adopted in some of the machines of American make now being installed in Canada.

The indenting of the cartridge case is carried out in a press somewhat similar to that used for heading, but requires much less force, the comparatively slight pressure of 280 tons being sufficient for this work.

The punch and die used in indenting are shown in Fig. 6. At *A* is the section of the shell as it comes to the press, while *B* shows the indenting operation completed and also the construction of the punch and compound die, which are quite similar to those used for heading.

THE HYDRAULIC ACCUMULATORS

Just as undertaking the job of making cartridge cases on planers and bulldozers seemed to entail the building of hydraulic presses, so this latter task brought

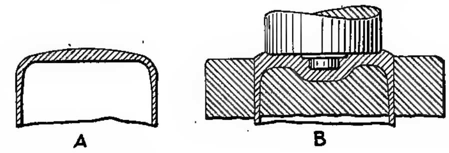


FIG. 6. PUNCH AND DIE USED IN INDENTING

forth the necessity of building hydraulic accumulators with which to operate them. Two of these have been built and erected at Angus up to the present time, a view of one of them being shown in the background of Fig. 2, page 834.

These accumulators consist of sheet-iron tanks filled with pieces of scrap steel and the like and mounted on cast-iron cylinders which slide up and down on cast-iron rams mounted on substantial bases. As work of this length is scarce in a railroad shop, no pits were

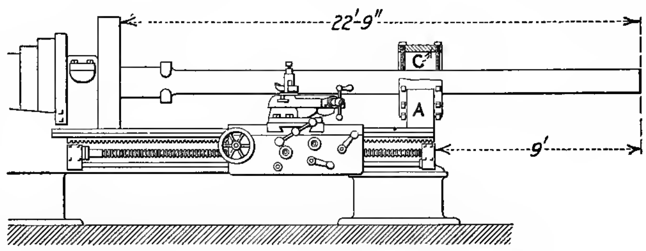


FIG. 7. A LATHE JOB THAT WAS MOSTLY OVERHUNG

available in which to cast the pieces in a vertical position. It was necessary, therefore, to cast them horizontally. Care was taken to provide risers of a size which would insure clean metal in the cope. Five 7-in. risers were cut in the cylinder mold, which was gated with horn gates at both ends. There was no time for the full drying of these molds, which were skin-dried with a torch to about 1/4 in. depth. This, in connection with the necessity of pouring from each end, made it rather

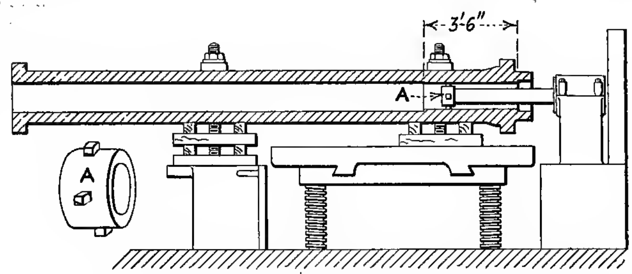


FIG. 9. BORING ACCUMULATOR CYLINDER ON BERTRAM HORIZONTAL MACHINE

difficult to avoid a wash. The cylinders and rams were made of 20 per cent. steel mixture. The excessive length of the cylinders and rams in these accumulators developed some interesting kinks as they passed through the machine shop. For example, no lathe in the shop had a long enough bed to swing the ram between centers.

When placed in the most suitable machine for this purpose, it overhung a distance of almost 9 ft., as shown in Fig. 7. A large, thin bushing, shown at *C*, was drilled and provided with a number of setscrews and served as a spider, running in a wooden saddle *A*, which is more clearly shown in Fig. 8.

The weight of this job was 10 tons, over one-half of it coming upon the comparatively small area of the wooden saddle, which caught fire from time to time and thus offered difficulty until some genius thought of turning the hose on it. Grease was plentifully used as a lubricant. By means of this crude device, a ram was produced which, when carefully inspected, was equal to what might have been the result of using a machine especially adapted for the purpose.

Another problem was that of boring the accumulator cylinder, which was handled as shown in Fig. 9. A wire was first run from the center of the boring spindle to a point on the shop wall, which was carefully marked, then the casting was placed upon the machine, the wire inserted through the core hole and re-located according to the mark previously established. The cylinder was then lined up from this wire, and the boring proceeded. It was necessary to maintain a very true hole, while at the same time the boring bar was overhung a distance of four feet.

Accuracy in this was aided by the shape of the cutters in the cutter head, shown at *A*. Clearance was ground on the front, or cutting edge, the back being ground to a radius equal to the finished cut, causing the cutters to act as follow-rests within the hole.

Taking it all in all, from hay presses to hydraulic accumulators, the Angus shops have had their share of unusual work during the last nine months. They have a great many achievements to be proud of and, not the least of these is their practical demonstration of the adaptability of railroad machinery and mechanics.

Fig. 5. Hydraulic Heading Press for 4.5 Cartridge Cases

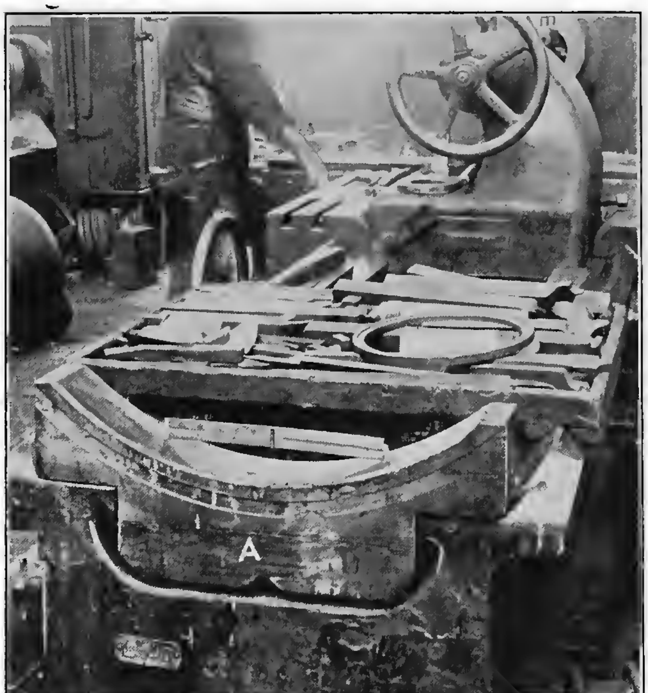


Fig. 8. Wooden Saddle Used to Support Accumulator Ram

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2. No gross exaggeration can appear.

3. The name or address of a competitor cannot be mentioned in an advertisement.

4. No advertisement of any product (or services) that cannot be used to advantage in a machine shop can be inserted in the American Machinist.

5. We reserve the right to refuse the advertising of any concern, if in our judgment the product is not ready to be marketed, or if the would-be advertiser is not financially able to continue advertising long enough to make his investment worth while.

The Manufacturing of Cartridge-Cases

Special Correspondence

SYNOPSIS—The manufacture of a cartridge-case for a 6-in. rapid-fire gun involves a number of exceedingly interesting press operations, requiring the evolution of a disk 14¼ in. diameter cut from sheet brass ⅔ in. thick into a tube 41½ in. long by 6 in. diameter, with thin walls and closed at one end with metal as thick as or thicker than the original disk.

The development of the modern rapid-fire gun has been made possible through the invention some 60 years ago of metallic cartridge-cases. For guns up to 3-in. caliber, the projectile, propelling charge, and primer are handled as a unit. From 3- to 6-in. caliber, the projectile and propelling charge as a rule are separate.

In Fig. 1 are shown three vertical presses, and in Fig. 2, a horizontal press similar to those used at the Government Arsenal, Washington, D. C., for manufacturing 3-in. cartridge-cases.

For the cases, brass has been found the most suitable metal; a satisfactory composition consists of 67 per cent. copper and 33 per cent. zinc. In its annealed state this alloy has an elastic limit of about 10,000 lb. tensile strength of about 45,000 lb., elongation of about 65 per cent. and reduction in area of about 30 per cent.

This metal cannot be worked hot, but is subjected to a series of cold drawings which harden it and make it brittle. The amount of deformation (from the previous shape) that the metal undergoes at each operation is determined by what it will stand without rupture or other defect which would interfere with the production of a perfect case. Each drawing operation is of necessity followed by an annealing operation to restore the metal to its former ductile state. The annealing operation is a heat treatment between certain limits of temperature, after which the work is cooled either rapidly or slowly, whichever is found to be most convenient; the speed of cooling does not affect the physical properties of the metal. Annealing temperatures vary from about 1150 deg. F. to about 1200 deg. F., depending on the thickness of the work.

The following description of the manufacture of 6-in. cartridge-cases is an abstract of a paper by Col. Leandro Cubillo and Archibald P. Head, read before the Institution of Mechanical Engineers, Oct. 20, 1905. The methods and tools used were devised by Oberlin Smith, president of the Ferracute Machine Co., of Bridgeton, N. J., and are practically the same as those used today. In the plant where these cases were made, hydraulically actuated presses were used for many of the operations. However, the type of press supplying the power is of little consequence; all other things equal, sufficient power and stroke for a given operation are the essentials.

The entire manufacture of metallic cartridge-cases involves a series of operations which, with the exception of a few, consist in cold-drawing. After being formed into a cup-shaped disk, the metal is subjected to successive

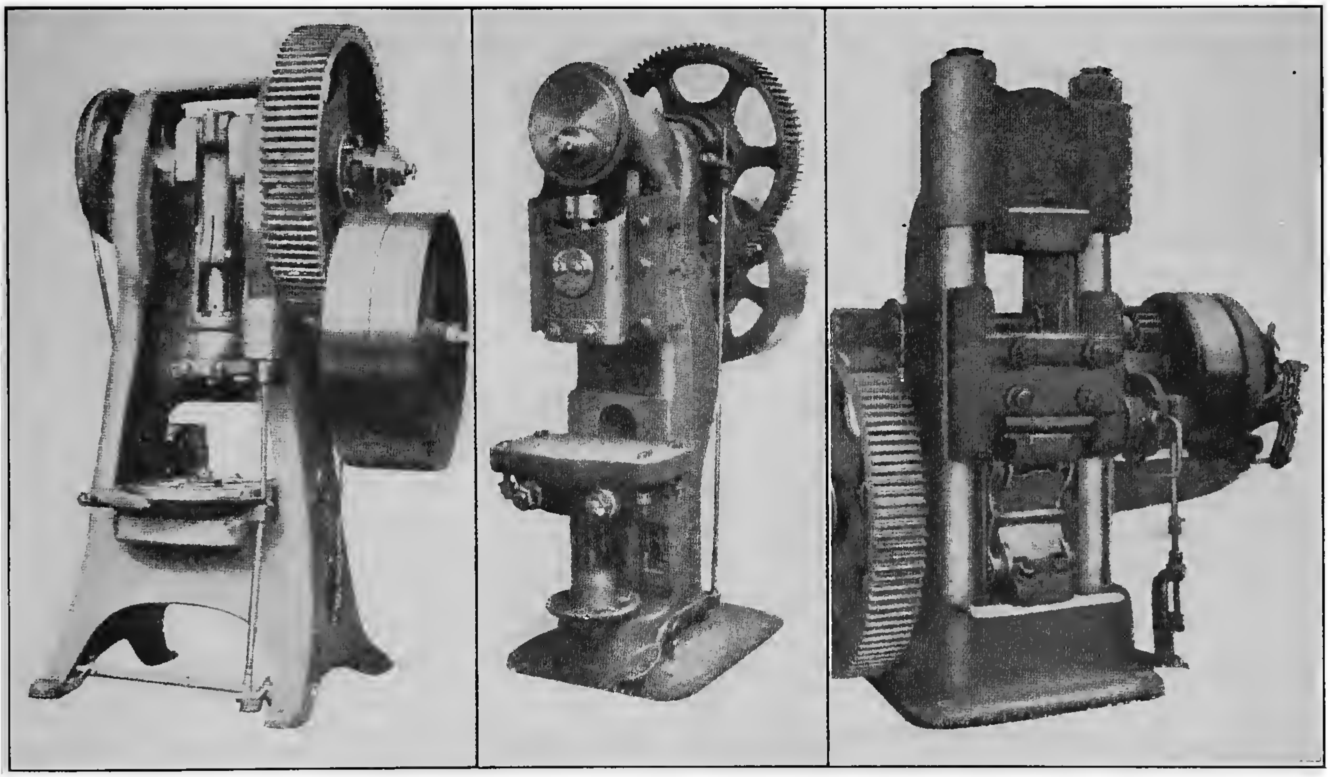


Fig. 1. Types of Vertical Presses for 3-In. Cartridge-Cases

drawings, the object of which is to diminish the diameter and thickness and to increase the length until the desired form is obtained; namely, a long cylinder, closed at one end, with side walls very thin at the open end and tapering to a considerably greater thickness where they join the still thicker end wall. During these operations the volume undergoes no appreciable alteration.

The earlier operations, while the cartridge-case is still short, are carried out in a vertical press, but when the length is such that the manipulation and the withdrawal of the punch become difficult, the operations are sometimes continued in horizontal presses. The two most important tools are the punch and the die. The punch is carried upon the extremity of the ram of the press and transmits the power acting upon the bottom of the cartridge-case, which is inserted in the larger end of the die. The die consists of a ring of hardened and tempered steel, the interior having the shape of a truncated cone and the axis being in line with that of the punch. The operation of drawing is performed by centering a partly drawn case in the large end of the die and advancing the punch until it touches the bottom of the cup. The pressure then comes into play forcing the cup through the small end of the die and thereby reducing the diameter of the cup and the thickness of the wall and increasing the length, a process which involves flow of metal. As the walls of the case are squeezed thinner, it is an interesting sight to see them crawling upward upon the sides of the descending punch.

Cupping

The brass disks *A* for the 6-in. cartridge-cases, Fig. 3, are 14.2 in. in diameter and 0.67 in. thick, with an allowable variation of thickness of 0.02 in. above or below. They weigh 33 lb. each, and should have a smooth surface with clean-cut edges.

The cutting of such blanks can be performed with the cutting tools shown at *B*.

For convenience the cupping is done in two stages with the punches and dies shown at *C* and *D*. The stroke of the punch is adjusted so that the cup is thrust just clear of the small end of the die. The die, punch and disk are greased, and the disk is placed on the top of the die. The press is tripped and the punch advances, forcing the disk through the die and out at the smaller end. On the return of the ram the cup is stripped from the punch and allowed to fall into a receptacle.

The cup then has a steel clip placed around it and is annealed for about 28 min. at 1164 deg. F. The scale formed in the annealing operation is removed by pickling in dilute sulphuric acid. The cups are then washed to remove every trace of acid. The second cupping operation is made in exactly the same manner as the first. The subsequent annealing lasts 20 min. at a temperature of 1202 deg. F. The pickling and washing processes which follow this and all other annealings are as before described. The behavior of the metal during cupping is an efficient test of its quality. The presence of impurities or improper annealing is quickly shown by cracks or a roughened surface.

Drawing Operations

At *E* are shown the punch and die used in the first drawing operation, also the resulting shell. The shells are annealed at 1202 deg. F. for 28 min.

The second drawing is performed with the tools shown at *F*. The subsequent annealing is at 1202 deg. F. for 26 min.

The third drawing is performed with the tools shown at *G*. The annealing is at 1184 deg. F. for 15 min.

Before the fourth drawing, the bottom of the piece is flattened preparatory to indenting, which takes place after the fifth drawing and is necessary for the formation of the primer hole. Flattening is accomplished by pressing the piece between the punch and a flat steel disk which takes the place of the die. After this operation the fourth drawing proceeds as usual with the tools shown at *H*. The subsequent annealing is at 1166 deg. F. for 22 min.

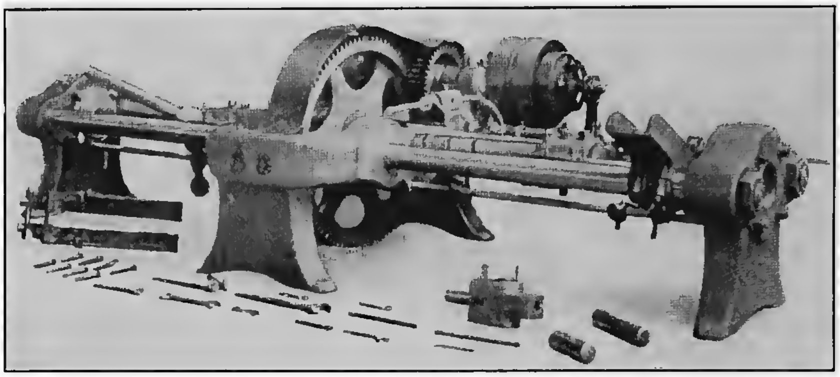


Fig. 2. Horizontal Press for 3-In. Cartridge-Cases

The fifth drawing is the last drawing operation performed in the vertical press. The tools used are shown at *I*. The annealing is at 1166 deg. F. for 20 min.

Indenting for the Primer

The indenting operation is done in a vertical press. A hinged anvil *J* is secured to the front of the base of the press and in line with the center of the ram. The anvil has the same exterior form as the interior of the cartridge-case after the fifth drawing, and has an indentation at the top. It is hinged to facilitate the insertion and withdrawal of the cartridge-case *I*. In the ram of the press is secured a punch *K* with a projection in the center. This and the recess in the anvil form in the case the boss for the primer. No annealing is done after indenting.

Subsequent Drawing Operations

From this operation onward horizontal presses are often used, because the length which the cartridge-cases have now attained may not permit of their manipulation in a shorter-stroke vertical press—unless indeed its stroke is made longer than usual.

The tools used for the sixth drawing are shown at *L*. Up to this point the cartridge-cases have been able to strip themselves from the punches by catching on the underside of the dies. But from the sixth drawing onward, other means of stripping are adopted. Under each die is an attachment containing eight fingers pressed inward toward the axis by springs. During the drawing they give way before the advancing case, retiring into recesses. But when the end of the case has passed them they spring

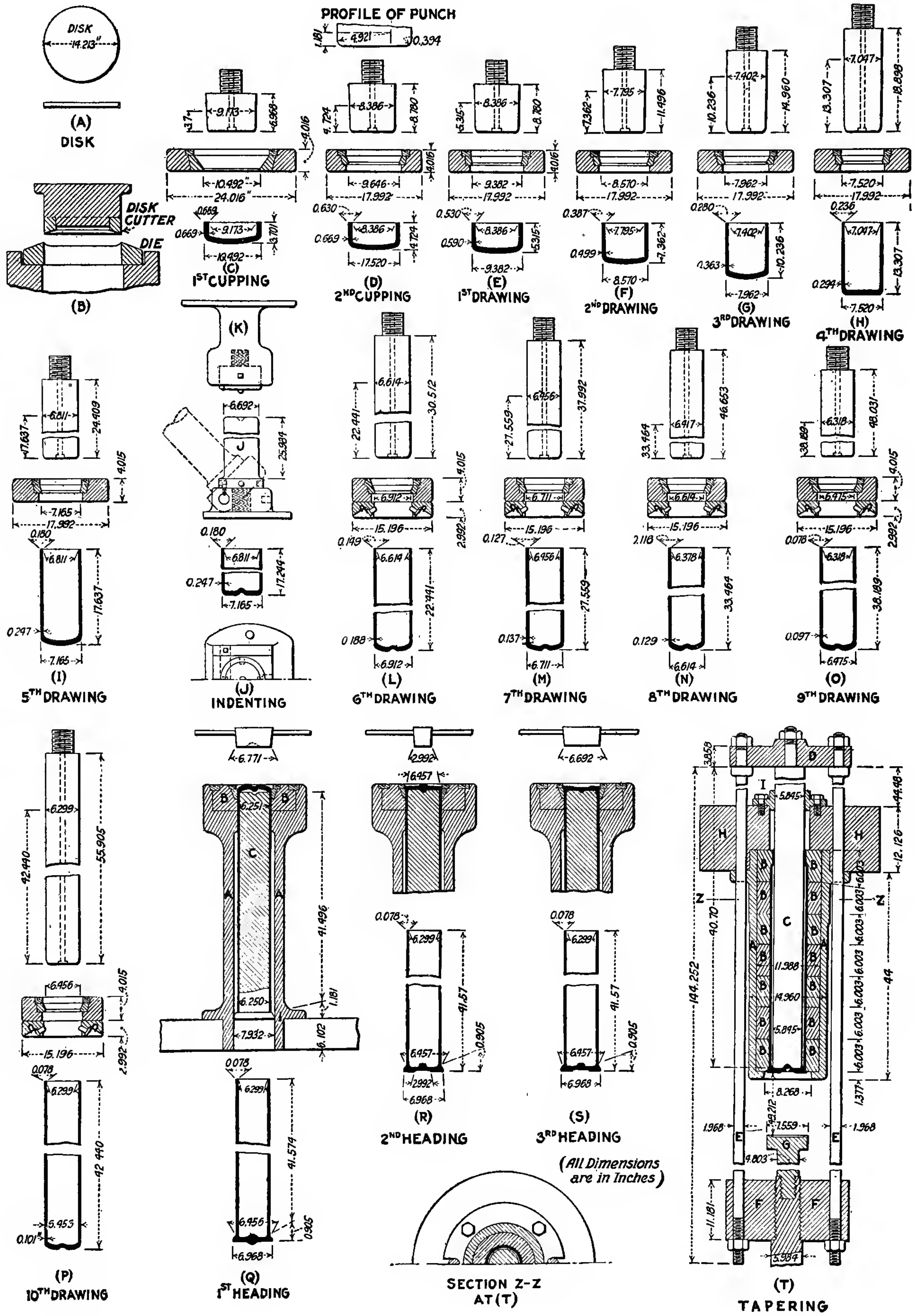


Fig. 3. Details and Sequence of Operations in Drawing Cartridge-Cases

out and keep the case from following the punch back, the inclination of the recesses in which they move assisting this action. The annealing following this drawing is at 1166 deg. F. for 18 min.

The tools used for the seventh drawing operation are shown at *M*. The annealing is at 1166 deg. F. for 15 min.

The tools used for the eighth drawing operation are shown at *N*, The annealing is at 1112 deg. F. for 14 min.

The tools used for the ninth drawing operation are shown at *N*. The annealing is at 1112 deg. F. for 14 min.

The tools used for the tenth drawing operation are shown at *P*. This is the last drawing operation, and the blanks undergo no annealing upon its completion.

Heading

The total pressure which the head of the cartridge is called upon to stand under fire is enormous. With the 6-in. quick-firing gun using these cartridge-cases the pressure caused by the explosion is some 38,000 lb. per sq.in. This pressure is exceeded by about 15 per cent. when testing the guns. When the area of the cartridge-case head is considered, some idea may be formed of the enormous aggregate pressure to which it is subjected. It is essential for the satisfactory working of the guns that no deformation should take place under fire, and it is therefore important that during manufacture the head should be subjected to a pressure two or three times that likely to be experienced in practice.

The operation of forming the head is made in a vertical 2500-ton press in three stages. The tools used for the first stage are shown at *Q*. An iron casting *A* is placed upon the ram of the press and serves to support the die-holder and die *B*, which form the flange on the shell. Inside the bolster is fixed a steel stem *C* over which the cartridge-case is slipped in the condition in which it leaves the tenth drawing. This stem is made of hardened steel and must be capable of withstanding an aggregate pressure of 1650 tons. The first heading operation is performed by inserting the cartridge-case between the stem and the bolster. Upon the top is also placed the punch *D* of hard steel, provided with a central depression, the object of which is to reduce the area of contact over which pressure is exerted on the head of the cartridge-case. The total pressure is 1600 tons, which leaves the head with a central internal and external projection, and forces the metal outward to form a flange.

At *R* is shown the second heading operation. This is performed with the same tools as the first, except that a 3-in. diameter punch instead of the punch *D* previously used is placed over the cartridge-case. A total pressure of 600 tons is exerted, with the result that the outside projection is flattened and all the metal is driven into the internal boss, thus allowing sufficient metal for the primer holes. Finally, the third heading operation is performed with the tools shown at *S*, a total pressure of 1650 tons being applied, with the result that the head is rendered flat and shapely.

Tapering

The tapering operation is for the purpose of giving to the cartridge-case its final external form, enabling it to fit the chamber of the gun and to be easily inserted and withdrawn. It is performed in a horizontal press. To the fixed head *H* of the press at *T* is bolted the cast-iron bolster *A*, inside of which are placed the seven rings *B* of tempered steel. The internal length of these, when thus assembled, is exactly equal to that of the gun-chamber. The cartridge-case is driven into this space by the press. As it is necessary forcibly to extract it after the operation, the special apparatus shown is made use of. The cylindrical extractor *C*, having a head shaped to fit the inside of the headed cartridge-case, is connected rigidly with the ram of the press through the crossheads *D* and *F* and the tie-rods *E*, and moves therewith, its position being kept central by the guide *I*. The punch *G*, bolted to the ram of the press, forces the cartridge-case in during the forward stroke, while the extractor *C* forces it out during the return stroke.

In some factories tapering is divided into two operations with annealing between, to avoid risk of cracking. Before the first tapering the cartridge-case is annealed at 1040 deg. F., care being taken to keep the head outside the furnace in the air so that it will not be annealed. It is then placed in the press and forced about one-half its length into the chamber, the precaution being taken to adjust the stop of the press to limit the stroke to one-half its usual length. On the return stroke, by the aid of a wooden distance-piece inserted between the extractor and the head of the cartridge-case, the case is forced out. It is then returned to the vertical annealing furnace, where it is exposed to a temperature of 932 deg. F., care being taken, as before, not to anneal the head. Tapering is then completed in the press, the cartridge-case being driven completely home into the die chamber.

Other Mechanical Operations

The remaining operations are of a mechanical nature, such as cutting to length, turning the end, the head, the steps in the chamber, and the attachment for the primer. Throughout the whole course of manufacture the thickness and diameter of the cartridge-cases are carefully checked with calipers and gages, particularly the first two or three cases in each lot, to verify the accuracy of the dies and the setting of the tools. The ends of the cases are frequently turned to length between the various drawing operations, since there is a tendency, due to irregularities of the metal or to uneven annealing, to stretch unequally, leaving ragged edges. It is also of great importance that the thickness of the end of the cartridge-case should be closely checked, and this is performed by limit gages. Lubrication of the punches and dies is effected by olive oil or soapy water, according to the stage in the process.

In the manufacture of cases for 3-in. shrapnel, cutting and cupping are done on a press similar to that shown at the left in Fig. 1. The production would be about 9600 in eight hours. Four drawing operations follow on a somewhat similar press, but one with a greater stroke. Such a press on this work would produce 4800 of any of the four operations in eight hours. Indenting is done on the press in the center of Fig. 1, but it is equipped with a swinging-post anvil instead of the table shown. The production would be about 9600 in eight hours. Two drawing operations follow on the horizontal press shown in Fig. 2. These are performed at the rate of about 1500 in eight hours. It will be observed that these 3-in. cases do not require as many draws as the 6-in. cases.

Forging 3.3 Shrapnel Blanks on Steam Hammers and Bulldozers

By E. A. Suverkrop

SYNOPSIS—At the Turcot works of the Canadian Car & Foundry Co., Ltd., Montreal, Canada, 1200 shell blanks are forged every 24 hours. The work is done on machines formerly used for forging railway-car parts and, excepting punches, dies and similar accessories, no money has been spent on special equipment.

Should the reader turn to page 889, Vol. 42, of the American Machinist and compare the illustration on that page with Fig. 1 of this article, he would be likely to remark: "After showing how a shell blank can be forged in three operations what's the use of showing how it may be done in seven?" The answer is: "Because in this shop not one penny has been spent for new machines. The bulldozers and steam hammers which have for years done the heavy forging work for railroad cars have been equipped with the necessary punches and dies and put to work on the shell job. Further, the method of handling the work differs considerably from that set forth in the previous article.

Cutting Off the Blanks

In this shop the cutting of the blank shown at *A*, Fig. 1, is done hot. The bar stock is received from the mill cut to lengths which are an exact multiple of $5\frac{3}{16}$ in., the length of *A*. With the shearing method there is no kerf to allow for, and should the last blank on a bar be too short to use for a forging, it is a solid chunk of scrap steel readily salable at a much better price than cuttings from a cold-saw.

The bars, approximately 6 ft. long, are heated 4 to 6 at a time in the furnace *A*, Fig. 2. Above is a rail running to the Acme forging machine *B* and carrying a trolley and rope block and fall for handling the bars to and from the furnace and machine.

The dies for cutting off are arranged as shown in Fig. 8, so that two blanks are cut each time the machine is tripped and completes its cycle of operation. Three men make up the gang. The equipment under their care is the furnace *A*, and forging machine *B*, Fig. 2, and the steam hammer in Fig. 4. Their work consists of simply cutting off the blanks *A* and upsetting them.

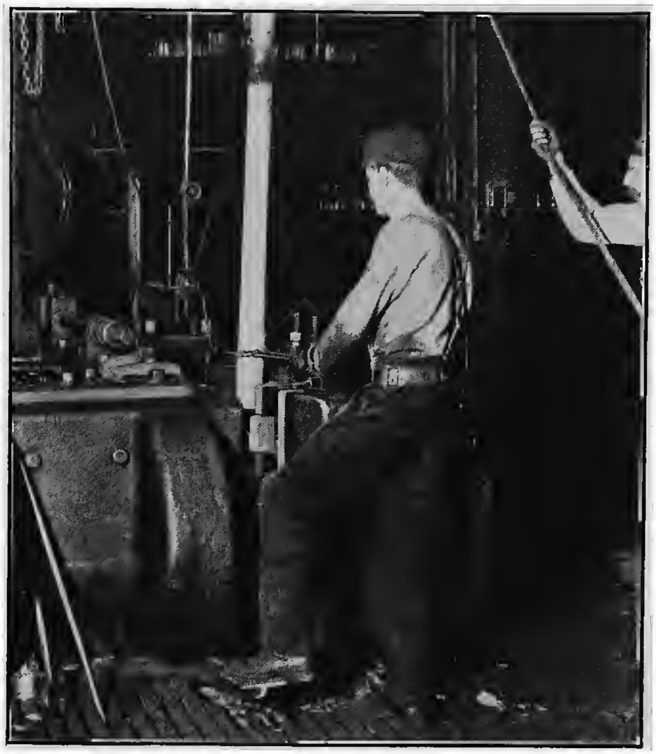


Fig. 3. Cutting Off

A bar *C*, Fig. 2, when properly heated, is hung by a clamp from the rope blocks and run over to the forging machine. One man carries up the weight while the other guides the bar into the dies and trips the machine with his left foot, all as shown in Fig. 3. The machine

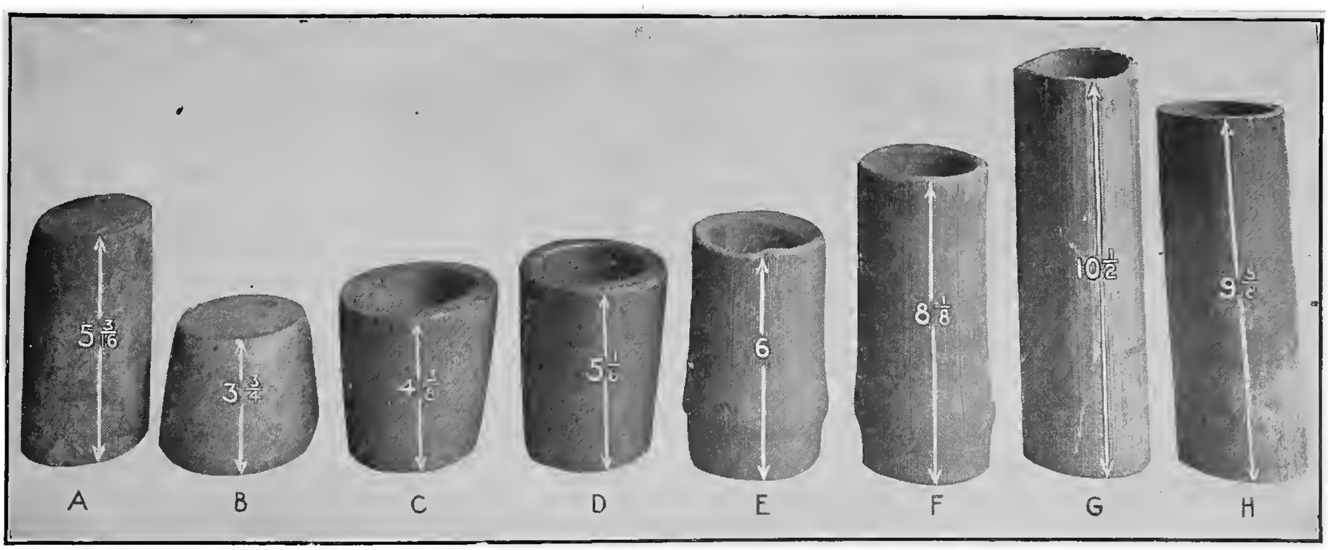


Fig. 1. From the Blank to the Trimmed Shell

runs about 40 strokes per minute, but cutting off is done at the rate of 8 to 10 pieces per minute, which is of course faster than the work can be heated for a continuous run. The daily output on this operation is 1200 pieces.

In Fig. 8 are shown diagrammatically the cutting-off dies used in the Acme forging machine.

The fixed holding dies *A* are secured to the housing *D* of the machine. It will be noted that the lower dies are $5\frac{3}{16}$ in. deep and are spaced $5\frac{3}{16}$ in. from the upper dies, both these measurements being equal to the length of the blank. The movable holding dies *B* are similar in all respects to the fixed dies *A*. The operation is as follows:

The red-hot bar is lowered till its end strikes the bottom *E*. The machine is then tripped, and the two movable holding dies *B* advance and clamp the bar in the fixed dies *A*. The shearing die *C* then advances and shears a blank out of the space between the upper and lower dies *A*, leaving a similar blank in the lower dies *A* and *B*. On the return of the slides to open position, the two sheared blanks are removed by the operator and the process repeated.

The life of the holding dies *A* and *B* has so far not been determined. They have been in the machine, running day and night for two months, and are still in good condition. One shearing die *C* has been replaced in this time.

Upsetting the Blanks

On removal of the sheared blanks from the machine, the operator throws them to the hammerman, who takes the hot blank and, placing it near the center of the anvil, brings the head down slowly to center it with relation to the die in the hammer head. From two to four sharp blows with the hammer shape it to the form the die. In Fig. 9 is shown the upsetting die without the dovetail dimensions for fitting to the hammer, as these would vary for different hammers.

The upsetting is done without reheating, direct from the shearing operation and by the same gang of men, so that each shift handles 600 pieces sheared and the same pieces upset—1200 handlings per shift.

The Piercing Operation

The upset pieces pushed off the steam-hammer block drop into the chute *A*, Fig. 4, whence they are trans-

Fig. 4. Upsetting the Blanks

ferred while hot to the furnace *A*, Fig. 5. Owing to their initial high temperature, a short time in the furnace is sufficient to bring them to forging temperature. The

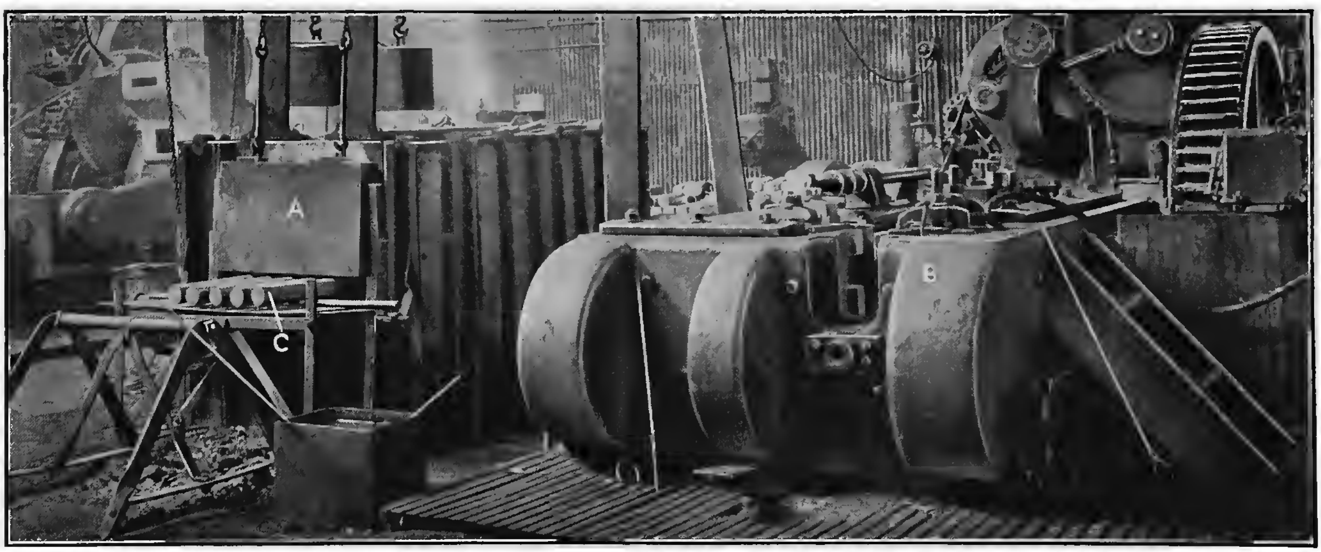


Fig. 2. Furnace and Cutting-Off Machine

shown at *B*, Fig. 1. With a new die in the hammer head, the upset piece readily drops out, and one man can handle the upsetting operation. When the die becomes worn, help is necessary and the two other men of the gang assist at the upsetting. The man to the left in Fig. 4 has a block of steel which, when placed as shown and struck with the hammer, jars the upset blank out of punch *B*, shown in detail in Fig. 10, is secured in the head. The block *C* is bored to receive the die *D*, shown in detail in Fig. 11.

The piercing operation is in reality two operations done with the same punch and die. When the upset blanks *B*, Fig. 1, are heated sufficiently, one of the piercing gang pulls one from the furnace *A*, Fig. 5, with the hook E. It falls into the chute F and, rolling down, is taken by the smith with a pair of pick-ups and placed in the die D. Two or three blows with the hammer drive the punch 2½ in. into the work and lengthen it about ⅝ to ¾ in. After this operation the blank is 4⅜ in. high, 3⅝ in. diameter at the bottom, 4½ in. at the top, and has a 3-in. hole 2½ in. deep. After removal from the die it is returned to the furnace

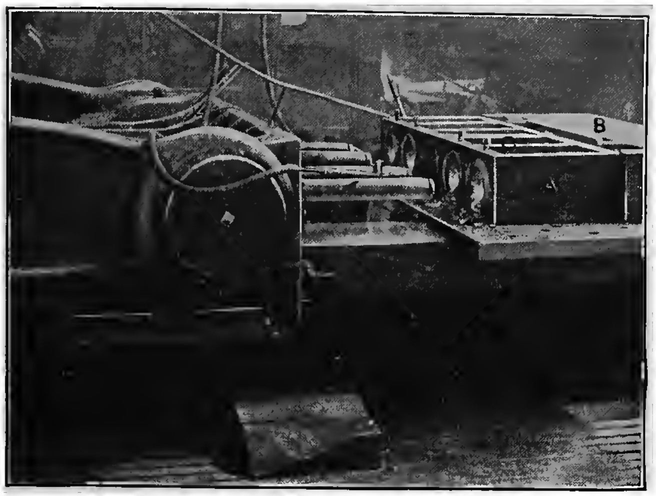


FIG. 6. FIRST AND SECOND DRAWING OPERATIONS

to be heated for the final piercing operation. This is done with the same punch and die and in the same manner, resulting in a blank measuring 5⅛ in. high, 3⅝ in. diam. at the bottom, 4⅜ in. at the top, and has a 3-in. hole 3¼ in. deep.

FIRST DRAWING OPERATION

On completion of the second piercing operation, or the fourth operation of the series, the work, while still hot, is thrown into the chute G, Fig. 5. Rolling to the other end, it is taken and placed without reheating in the first-operation drawing die.

The bulldozer, Fig. 6, is provided with four punches and four dies. The two at the front are for the first drawing operation and the two at the back for the second drawing operation, shown respectively by the shells E and F in Fig. 1.

The two dies for the first drawing operation are of chilled iron as shown in the detail Fig. 12 with a 3⅞-in. hole. Both sets of dies are used alternately to prevent overheating. The hot blanks are taken direct from the previous operation and, held with a pair of pick-ups, are slipped over the end of the advancing punch. This forces the work through the drawing die and at the completion of the stroke pushes it into a base-forming die seated in the fixture at B. The effect of this base-forming die can be readily seen at the bottom of the pieces E and F, Fig. 1. The bottom-forming die is shown in the detail, Fig. 13. The bulldozer runs at a speed of 9 strokes per minute.

After being formed to the shape shown at E Fig. 1, the hot piece is returned to the furnace. The work comes from the first drawing operation, 6 in. long, 3⅞ in. diameter at the top, 3⅝ in. at the bottom, and has a 3-in. hole 5 in. deep.

SECOND DRAWING OPERATION

The blanks from the first drawing operation, having reached a full yellow heat, are pushed through the second drawing dies in the bulldozer, Fig. 6. These are similar to the first operation drawing dies, except that they are ⅛ in. smaller in diameter, measuring 3¾ in. at the small end of the throat. The punches used for all the drawing operations are as shown in Fig. 14. From the second drawing operation the work is as shown at F, Fig. 1, 8⅛ in. long, 3¾ in. diameter, with a 3-in. hole 7⅜ in. deep.

THIRD AND FINAL DRAWING OPERATION

The work is taken direct from the fixture A, Fig. 6, and without reheating is passed through the final drawing operation. The operator takes the piece from the machine A, Fig. 7. Holding it with a pair of tongs, gripping the wall of the open end, he lays it on the iron plate B. With a heavy hand hammer he pounds the outside as he turns the piece. This loosens the scale

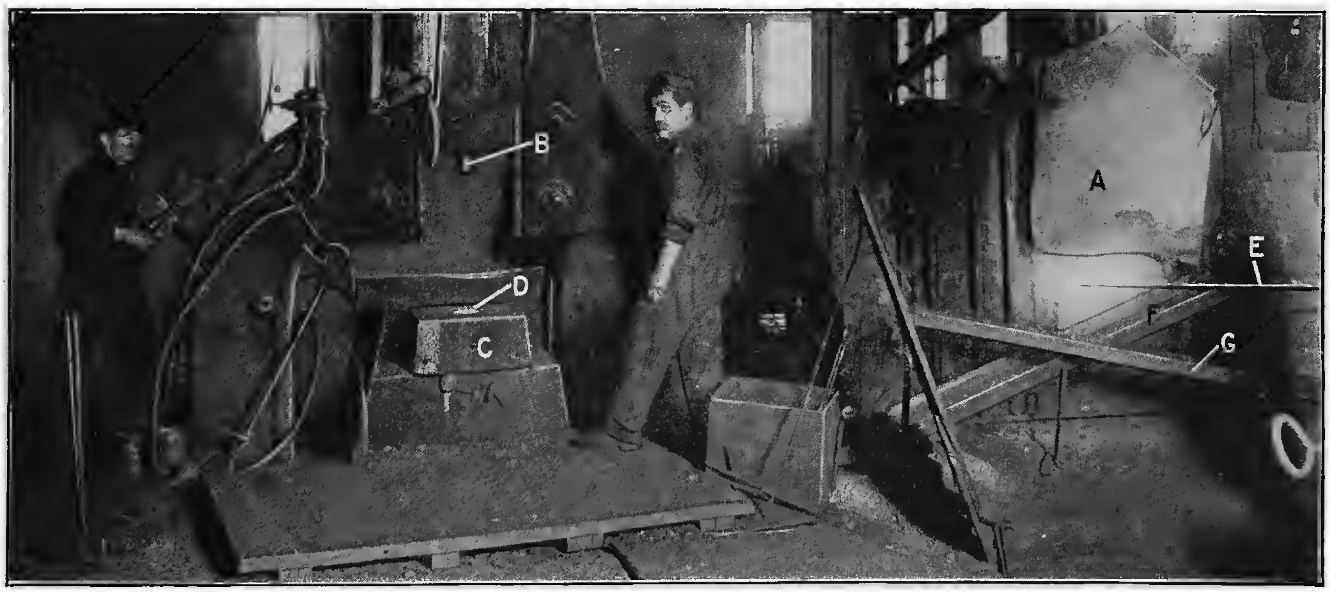


FIG. 5. FIRST AND SECOND PIERCING OPERATIONS

on the inside. He then passes the piece to the feeder of the last-operation bulldozer. This man grips it with a pair of pick-ups, and swinging over his head, brings it mouth down on the machine frame at *C*, jarring the loose scale out. It is then put on the punch and passed through the final-operation die. In this machine the base-forming die is replaced with a flat die which, just at the completion of the stroke, flattens the bottom and imprints the company's mark. The work is then laid on *D*, where the inspector gages it, after which it is placed for a few moments in the furnace *E* to relieve stresses caused by forging at the comparatively low temperature.

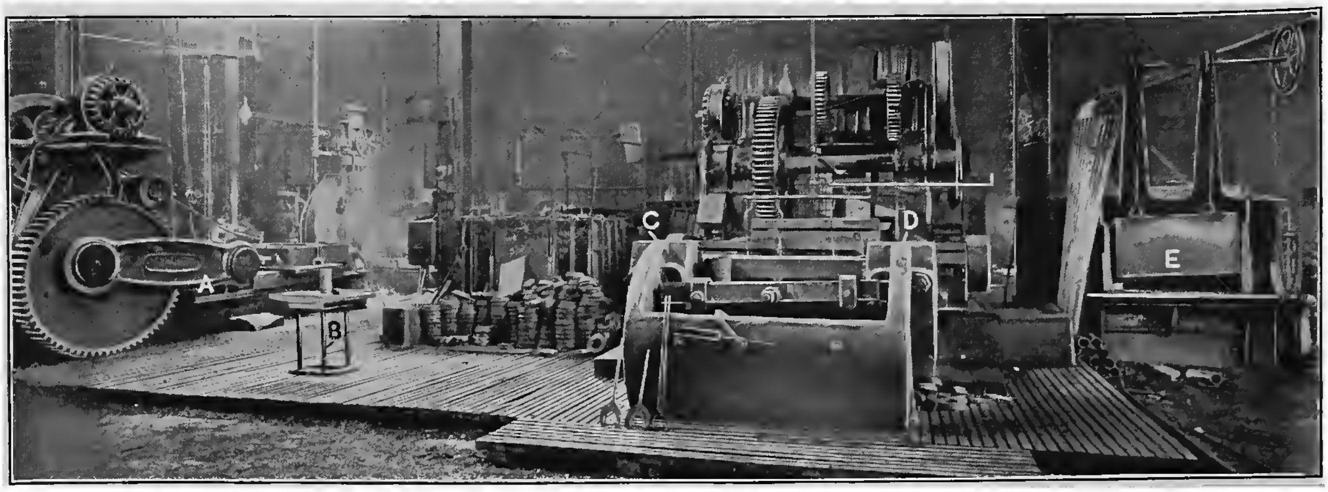
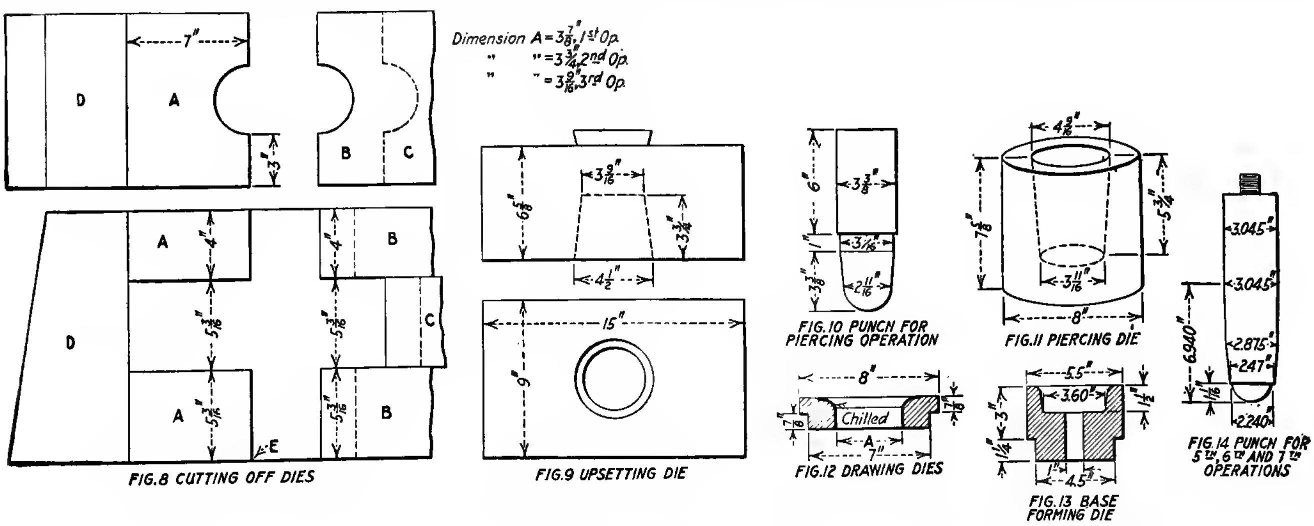


Fig. 7. Arrangement of Machines for Drawing Operation

The work from the final drawing operation is 10½ in. long, 3½ in. diameter, with a 3-in. hole 9¾ in deep. It has an imprint on the bottom "C.C." with a "T" below, signifying Canadian Car and Foundry Co., Turcot Works.



Figs. 8 to 14. Details of Punches and Dies Used in Forging Shrapnel-Shell Blanks on Steam Hammers and Bulldozers

General Features

Each of the four gangs (in a shift) with the exception of the first, which has three men, is composed of four men. Each gang handles two operations. The work is heated once for each two operations. The various reheatings are done on metal which is seldom allowed to get below a full-red heat, so that the consumption of fuel and loss of time in heating are insignificant. This method of handling the work results in considerably less scale trouble, and the finished work, as shown at *G*, is practically without scale.

The present output of the 30 men (8 gangs) is 1200 finished forgings every 24 hours. With the installation of another steam hammer, which has been moved from another part of the works, it is expected that the output (with 3 more men) will be doubled, as the two bulldozers are at present idle about half the time.

The methods used are improvements based on the early practice of the Montreal Locomotive Co. before their present special machines were installed. The tools and the method of stripping the work and mounting the dies and punches are, with slight modifications, as shown in the article beginning on page 889, Vol. 42. It is therefore unnecessary to reproduce them here.